T-SHAPED ENGINEER: HORIZONTAL COMPONENT COMPRISING OF SOFT SKILLS

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Keywords

Breadth of knowledge, engineering program, soft skills, T-shaped engineer

Abstract

Under 21st century conditions, engineering education should focus not only on professional skills such as design, manufacture, and maintenance but also on soft skills, which play an important role in supporting career advancements, such as communication, interpersonal relations and teamwork. In other words, it is an obligation for engineers to be competent in their own discipline. In addition to its own discipline, it will be a plus to be able to work with individuals from other disciplines and to exchange information seamlessly in the work environment. In this context, graduation as a T-shaped engineer with sensitive skills that will enable this acquisition will be prominent in career planning. The aim of this study is to introduce the T-shaped term that is not yet widespread in Turkey and to investigate soft skills forming the horizontal component of the T-shaped engineer. In line with the purpose of the research, studies on the soft skills that engineers must acquire, the program outcomes determined by the accreditation boards and job ads are analyzed. In addition to the determination of soft skills, suggestions compiled from the literature are presented for higher education institutions to train their students as T-shaped engineers.

T-TİPİ MÜHENDİS: HASSAS BECERİLERDEN OLUŞAN YATAY BİLEŞEN

Anahtar Kelimeler

Bilgi genişliği, mühendislik programı, yumuşak beceriler, T-tipi mühendis

Öz

21. yüzyıl koşullarında mühendislik eğitiminde sadece tasarım, üretim ve bakım gibi profesyonel becerilere değil, aynı zamanda iletişim, kişiler arası ilişkiler ve ekip çalışması gibi kariyer ilerlemesini desteklemede önemli rol oynayan hassas becerilere de odaklanılması gerekmektedir. Diğer bir ifadeyle mühendislerin kendi disiplininde yetkin olması bir mecburiyettir. Kendi disiplininin yanı sıra diğer disiplinlerden gelen bireylerle çalışabilme ve çalışma ortamında sorunsuz bir şekilde bilgi alışverişinde bulunabilmesi artı değer olacaktır. Bu çerçevede bu kazanıma imkân sunacak hassas beceriler ile T-tipi mühendis olarak mezun olması kariyer planlamasında öne çıkacaktır. Bu çalışmanın amacı Türkiye'de henüz yaygın olmayan T-tipi mühendis kavramının tanıtılması ve T-tipi mühendis kavramının yatay bileşenini oluşturan hassas becerilerin araştırılmasıdır. Araştırmanın amacı doğrultusunda mühendislerin sahip olması gereken hassas becerilere ilişkin literatürdeki çalışmalar, iş ilanları ve mühendislik programlarını akredite eden kuruluşların belirlemiş olduğu program çıktıları analiz edilmiştir. Hassas becerilerin belirlenmesine ek olarak yükseköğretim kurumlarının öğrencilerini T-tipi mühendis olarak yetiştirebilmesi için literatürden derlenen öneriler sunulmuştur.

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1. Introduction

In the 2018 ManpowerGroup Talent Shortage Report, it was stated that talent shortage rose to 66% in Turkey. It was specified that the first reason for this situation is the lack of experience. Moreover, the insufficiency of soft skills is among the top five causes of talent shortage (ManpowerGroup, 2018). The same report indicated that, in Turkey, while the first of the positions with the most skill gap is the qualified worker, the latter is an engineer. As a reason for this situation, industries, professional organizations, and international organizations were pointed out the weakness in the soft skills of newly graduated engineers (Direito, Pereira, and de Oliveira Duarte, 2012).

The globalizing economy demands high-quality soft skills from engineers to meet the needs of fast-growing global industries. But, while today's engineering graduates have an abundance of technical knowledge, most engineers lack the soft skills required by modern business environments, such as effective communication, negotiation or teamwork. Several studies in the literature corroborate this opinion. O'Neal (1990) argued that most engineers got behind in their careers not with the lack of technical knowledge, but with the inability to communicate their ideas to others and to take the lead. Moreover, he emphasized that engineering and science courses were not as effective as these soft skills for a career. In the Willmot and Colman (2016)'s study, it was stated that students spent 80% of their time learning technical subjects, but these technical skills were only 20% of the working day of the individual. Another similar research conducted by the Stanford Research Institute and the Carnegie Mellon Foundation identified that long-term business performance depended on 75% of soft skills and on 25% of technical skills (Abbas, Abdul Kadir and Ghani Azmie, 2013).

Most developed countries focus not only on professional skills such as design, production, and maintenance but also on soft skills such as communication, interpersonal relationships, and teamwork (Vedhathiri, 2016). Bilsel, Oral, and Pillai (1998) stated that many large companies in the United States preferred liberal arts students for management positions. The reason for this situation was expressed that individuals who graduated from engineering and science thought only functionally when making decisions and their expressions were limited to textbook definitions and formulas. In addition, it was stated that conceptualization and problem-solving approaches of students who graduated from liberal arts and humanities were multidirectional, creative and innovative unlike individuals graduated from engineering and science. In the light of such information, it was deduced that engineering education should be considered as a system of interrelated ideas and scientific fields rather than isolated knowledge fields. Furthermore, it was seen that soft skills play an important role in increasing employability, supporting job and career growth. For this reason, education should not only be restricted to academic learning but also should support to develop soft skills that enable the development of professional skills and their efficient use.

The major contributions of this paper are outlined as follows:

(i) The introduction of the T-shaped engineering concept, which is not common in Turkey but a remarkable concept worldwide, from an academic platform. Thereby ensuring to increase the awareness of this concept.

(ii) Listing of soft skills that engineers should acquire for working life.

(iii) Contributing to a small number of studies in the literature on soft skills that engineers should acquire.

(iv) Considering the expectations of the sector when determining soft skills. Thus, helping to reduce the sector's expectation gap.

(v) Compiling the proposed approaches to teach engineers soft skills.

2. Preliminaries

In this section, some basic definitions of "T-shaped engineer" and "soft skills" are reviewed in order to help the readers understand and to facilitate further discussions.

2.1 T-Shaped Engineer

Researchers developed different metaphors such as I, □, H, P, E, etc. in order to qualify a person's knowledge and skills diversity. For example; if the person has deep knowledge in one field, this person can be described as I-shaped; if the person has deep knowledge two fields, this person can be described as H-shaped or □-shaped; if the person has broad knowledge in many fields and doesn't have deep expertise in any field, this person can be described as a generalist. In addition to these representations, the individual, which has a deep knowledge of a single area (vertical bar) and also has a wide range of skills (horizontal bar), is identified as the T-shaped. Although the concept of T-shaped represented in Figure 1 appeared firstly in Palmer's (1990) article discussing the need for hybrid managers in the world of technology, the first known use of this expression belongs to David Guest who is editor of London newspaper (Wu, Zou, and Kong, 2012).

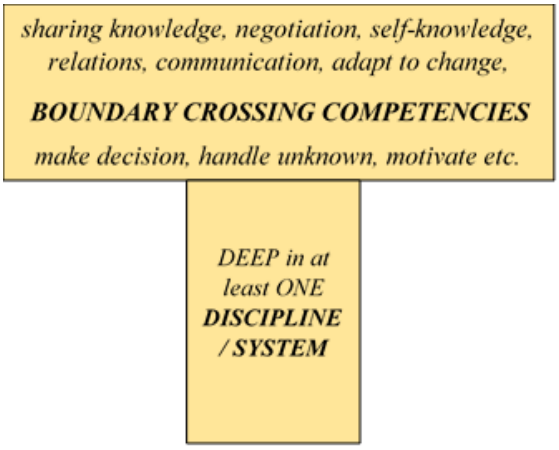

Figure 1. An Extended T-Shaped Representation for an Engineer (Cederberg, Axehill, and Herzog, 2019)

Unlike I-shaped individuals who specialize in a single field, T-shaped persons have in-depth knowledge of the one field, and also general knowledge in many fields. T-shaped persons can understand problems faster and produce solutions swiftly thanks to their interdisciplinary knowledge and experience (Donofrio, Spohrer, Zadeh, and Demirkan, 2010; Demirkan and Spohrer, 2015).

In the past, having simple technical skills was almost enough to have a successful and stable career in engineering disciplines. However, technical skills are not sufficient for 21st-century conditions, also the expectations of employers change according to the necessities of the time. With new expectations, interest in T-shaped engineers has begun to spread in many areas. Many managers including Tim Brown, CEO of the international design and consulting firm IDEO, and Jim Spohrer, one of the managers of IBM, stated that T-shaped personality is important in the recruitment process (Tranquillo, 2017). IBM's T-shaped individual representation is shown in Figure 2. It was seen that individual must have soft skills such as collaboration, teamwork, lifelong learning, analytical thinking in addition to technical skill (Figure 2).

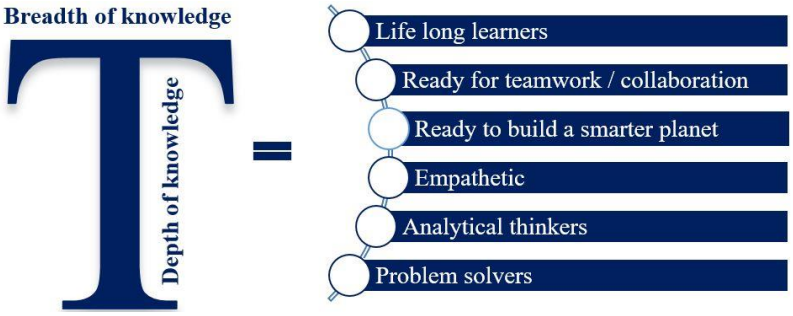

Figure 2. IBM's T-shaped Individual Representation (Miller, 2015)

2.2 Soft Skills

Different terms such as 21st century skills, applied skills, human skills, interpersonal skills, general skills, social skill were proposed for soft skills by many organizations and institutions, including the World Health Organization (WHO), and the Organization for Economic Cooperation and Development (OECD). Some of the proposed terms are shown in Figure 3.

WHO,1993	• Life skills
ISFOL,1998	• Transversal skills
Tunning project, 2000	• Generic competences
OECD, 2003; 2012	• Key competencies
UE, 2006	• Key competences for lifelong learning
Ananiadou ve Claro, 2009	• 21st century skills
IFTF, 2010	• Future work skills
Manpower Group, 2014	• Soft Skills for Talent
OECD, 2015	• Skills for Social Progress

Figure 3. Different Names Suggested for Soft Skills (Cimatti, 2016)

In the literature, there is not a common opinion about the definition of soft skills frequently mentioned in different terms. The different definitions compiled from the literature are presented below.

- Soft skills are communicative abilities that increase one's effectiveness in general and provide support in interacting with other people (Penzenstadler, Haller, Schlosser, and Frenzel, 2009)
- Soft skills are not specific to a job position or workplace environment but are commonly used skills in all jobs and tasks (Nasir, Ali, Noordin and Nordin, 2011).
- Soft skills are transferable behavior that can be used in a wide variety of functions and activities (Direito et al., 2012).
- Soft skills are character traits, attitudes, and behaviors rather than technical ability or knowledge (Robles, 2012).
- Soft skills are personal and interpersonal skills necessary for personal development, social participation and working in a particular employment environment (Taylor, 2016).

3. Method

In order to determine the soft skills that engineers should have in order to be trained as T-shaped engineers, literature, job ads, and the program outcomes determined by the accreditation boards were analyzed. Theoretical framework of this study is presented in Figure 4. In this study, it is declared that ethics in research and publication were followed and that there is no need for legal or special permission.

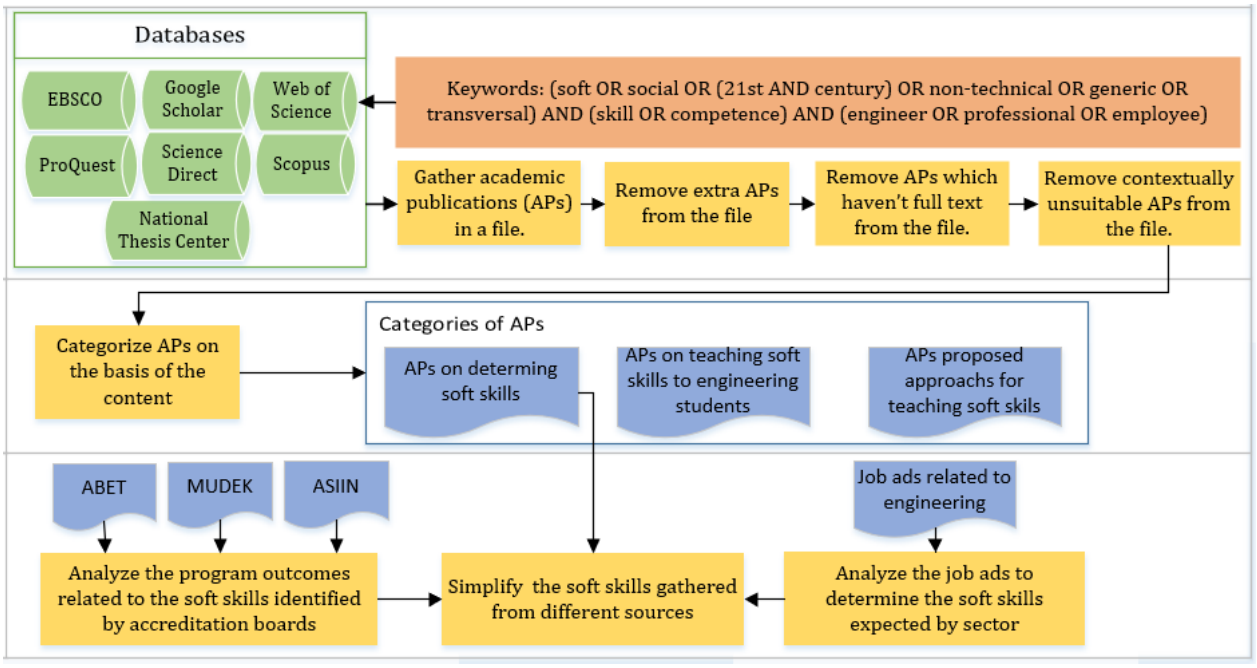

Figure 4. Stages of Determination of the Soft Skills

3.1 Literature Research

Academic publications analyzed in this study, got by searching EBSCO Open Dissertations, ProQuest Digital Dissertations, Council of Higher Education National Thesis Center, Google Scholar, Science Direct, Scopus, Web of Science databases. Database searching performed by using the terms: (soft OR social OR (21st AND century) OR non-technical OR generic OR transversal) AND (skill OR competence) AND (engineer OR professional OR employee). After the database research, academic publications were analyzed. If a publication was downloaded more than once, the extra publication(s) were deleted. Moreover, if publications that didn't have full text or were unsuitable in terms of content, they were also removed.

When the studies that were deemed appropriate in terms of content separated under three main categories by taking account of the aim of the study. These; (i) publications on determining soft skills, (ii) publications on teaching soft skills to engineering students by higher education institutions, and (iii) publications on recommended approaches for teaching soft skills. Moreover, it was seen that some of the studies conducted research for a specific engineering field while others studied by gathering all engineering departments under the title of engineering in general. In this section, soft skills collected by analyzing publications on determining soft skills for engineers are presented in Appendix 1. Moreover, some of these publications are summarized below.

Khamisani, Siddiqui and Bawany (2006) purposed to identify the soft skills required by software engineers, to analyze the relative importance of these skills and their relationship to each other. For this aim, a survey was created by using the theory of personal construct. When this survey analyzed by using repertoire charts and data mining techniques,

problem-solving, analytical thinking and coping with difficulties were found to be important skills. Furthermore, it was discovered that administrators gave importance to appearance, although software engineers thought that the appearance was insignificant. In the study of Ahmed, Capretz and Campbell (2012), job ads were analyzed for software engineers to determine the soft skills demanded by firms. As a result of the analysis, communication skills, analytical thinking, problem-solving skills, and teamwork were determined as the most preferred skills. Matturro (2013) analyzed job ads for software engineers to determine the soft skills demanded by firms. Analysis results showed that seventeen skills were determined and most requested soft skills were stated as knowledge of the foreign language, entrepreneurship, teamwork, responsibility, and desire to learn. Yanaze and Deus Lopes (2014) examined job ads to determine the expectations of the current labor market in the field of electrical and computer engineering. In results, it was seen that communication skill was the most preferred feature among the expected soft skills, followed by teamwork and leadership. In the Naiem and Abdellatif (2015)'s study, in order to determine the most important skills expected from software engineers, surveys and interviews were conducted with employers. As a result of the surveys and interviews, the most important skills were found to be problem-solving, analytical thinking, communication skills and self-learning skills.

3.2 Analysis of Program Outcomes Identified by Accreditation Organizations

Each engineering program must identify the educational objectives that serve the mission and vision of the university. The learning outcomes of the engineering program should be determined in order to achieve the educational objectives of the program. Learning outcomes are the skills, knowledge, and behavior acquired through the courses in the program. Learning outcomes are generally derived from criteria established by well-known accreditation authorities and the learning outcomes of the program are expected to be achieved through the outcomes of different courses in the program (Khan, Mourad and Zahid, 2016).

When the undergraduate level engineering programs in Turkey are examined, it is seen that 17.4% of engineering bachelor's degree programs are accredited by national accrediting institution MÜDEK (Association for Evaluation and Accreditation of Engineering Program) , 3.3% of these programs are accredited by international accreditation institution ABET (Accreditation Board for Engineering and Technology) and 0.4% of these programs are accredited by ASIIN (Accreditation Agency for Degree Programs in Engineering, Informatics, Natural Sciences and Mathematics) in Figure 5.

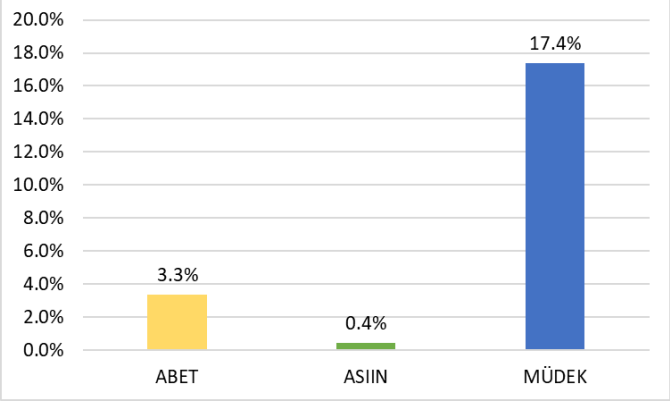

Figure 5. Rates of Accredited Undergraduate Level Engineering Programs

Accreditation organizations state that broad program outcomes are required to understand the impact of engineering solutions in a global, economic, environmental and social context in addition to technical training. Furthermore, these institutions have a common view that a general

education component consistent with the program and institution objectives completing the technical content of the curriculum should be included in the curriculum (Lyman, 2001). Program outcomes of ABET, MÜDEK, and ASIIN are examined and soft skills proposed by them are summarized by adapting to the skills in the appendix list, as in Table 1. When analyzed this table, it is seen that accreditation boards consider important not only mathematics, science, or technology but also soft skills such as effective communication, lifelong learning, teamwork.

Table 1
Soft Skills Proposed by Accreditation Boards

Soft Skills	ABET	MUDEK	ASIIN	Soft Skills	ABET	MUDEK	ASIIN
Analytical thinking	✓	✓		Personality development		✓	
Apply knowledge in the workplace	✓	✓	✓	Practical thinking and acting	✓	✓	
Communication	✓	✓	✓	Presentation skill		✓	
Creative/Innovative	✓	✓		Problem solving	✓	✓	✓
Critical thinking	✓	✓	✓	Program / Project management		✓	
Decision making	✓			Research skill	✓	✓	
Ethic	✓	✓		Responsibility	✓	✓	✓
Interdisciplinary relation and different view points		✓	✓	Teamwork and collaboration	✓	✓	✓
Interpersonal relation	✓	✓	✓	Using of foreign languages effectively		✓	
Leadership	✓		✓	Using of information and communication technologies effectively			✓
Learning individually	✓	✓					
Willingness to learn	✓	✓		Work individually	✓	✓	✓
Lifelong learning		✓	✓	Writing skills		✓	

3.3 Analysis of Job Advertisements

The difference between soft skills acquired at the higher education institutions and industry expectations has been referred to as an "expectation gap" (Dubey and Tiwari, 2020). It is important to analyze job advertisements so as to avoid the expectation gap for this study. To determine the soft skills that the sector expects from engineers, 500 job advertisements published by companies of different sizes in April and May 2019 were reviewed. The soft skills most demanded in 500 job ads are presented in Table 2. Soft skills that are frequently requested in job ads are in the soft skill list compiled from the literature.

Table 2
Soft Skills Compiled from the Job Ads

(i)	Analytical thinking	(viii)	Open to change
(ii)	Ambitious	(ix)	Open to self-improvement
(iii)	Communication skill	(x)	Persuasive skill
(iv)	Detail-oriented	(xi)	Prone to collaboration
(v)	Effective presentation skill	(xii)	Sociable
(vi)	Experienced in team management	(xiii)	Successful in teamwork
(vii)	Human relationship	(xiv)	Target and result oriented

4. Proposed Approaches for Soft Skill Acquisition

Higher education has an important role in producing human capital to meet the challenges of the global world (Abbas et al., 2013). Therefore, higher education institutions should educate students according to the 21st-century conditions, which is the new era of the global economy. Today, however, many engineering programs cannot provide appropriate training (Berglund and Heintz, 2014). Higher education institutions' activity about soft skills teaching has been in place as a controversial topic in literature (Nair, Patil and Mertova, 2009; Özsoy, 2013; Bayram, Çelik and Oral, 2015; Esa, Selamat, Padil, and Jamaludin, 2014; Naiem et al., 2015; Wilson and Marnewick, 2018; Uçar and İşleyen, 2019). These studies evaluating the opinions of students and graduates showed that course content doesn't meet adequately the knowledge and skills necessary for working life and that higher education institutions do not give enough importance to soft skills as much as technical skills.

The difficulty of determining the role of soft skills in the education of engineers, how much of the curriculum should be reserved for soft skills or what kind of courses should be integrated into curricula are among the topics in the literature. In the literature, the researches about the acquisition of soft skills to students were examined and approaches offered by authors were presented in Table 3. The most suggested approaches are those that enable students to actively participate in courses. Active learning methodology, case-based learning methodology, problem-based learning methodology, project-based learning methodology are examples of these approaches. It is thought that approaches to encourage active participation will be able to develop soft skills such as communication, cognitive skills, time management, presentation skills, teamwork, collaboration, technical writing, listening skills, conflict management, decision making, etc.

Table 3
Approaches Proposed in the Literature

Approaches	**References**
Active learning methodology	Nicola, Pinto and Mendonça (2018), Vega and Ortiz (2018), Duarte, Malheiro, Arnó, Perat, Silva, Fuentes-Durá, Guedes and Ferreira (2019).
Case-based learning methodology	Ktoridou, Doukanari and Karayiannis (2019)
Group activity	Kaushal (2018), Hoang and Do (2019)
New course proposal for soft skills	Berglund and Heintz (2014), Cukierman and Palmieri (2014), Sousa and Mouraz (2014)
Problem-based learning methodology	Kumar and Hsiao (2007), Deep, Salleh, and Othman (2019), Ktoridou et al. (2019)
Project-based learning methodology	Hayati and Mir (2004), Fernandez-Samaca and Ramirez, (2010), Jimenez, Pardo, Minguez, and Cuervo (2015), Moliner, Guraya, Lopez-Crespo, Royo, Gamez-Perez, Segarra and Cabedo (2015), Ballesteros Sánchez, Ortiz Marcos, Rodríguez Rivero, and Juan Ruiz (2017), Barros and Bittencourt (2018), Cavalcante Koike, Viana, and Vidal (2018), Vega and Ortiz (2018), Duarte et al. (2019)
Seminar	Hilmer et al. (2007), Abbas et al. (2013), San-Valero, Robles, Ruano, Martí, Cháfer and Badia (2019)
Service-learning	Kumar and Hsiao (2007), Dobrydina, Kersh, Kononova, Shipilova, and Usvyat (2019), Sin, Vui and Meng (2019)
Student clubs and committees	Willmot and Colman (2016), King (2019)
Summer internship	Khamisani et al. (2006)
University-industry cooperation program	Hairi, Toee, and Razzaly (2011)
Updating the course according to the soft skills	Andersson and Logofatu (2018)

Among the suggested methods for teaching soft skills to students, the most difficult is to add new course/courses to the curriculum. This is because adding new courses to the curriculum requires restructuring and reducing existing course credits. In addition, this process may affect the workload of other courses and may require to update the whole of the curriculum. During the process of teaching soft skills, first of all, a seminar explaining the importance of soft skills should be organized and awareness should be gained to the students. In addition, students should be given lifelong learning awareness and the importance of lifelong self-improvement of the engineer should be emphasized. Then, by using approaches such as project-based learning in which the students actively take part in the courses in the curriculum, students' individual learning, presentation, teamwork, interpersonal communication, time management skills can be developed.

5. Discussion and Conclusion

Rapidly changing technological, demographic, and economic conditions create new demands. Employers expect engineers to graduate with the employability skills required by the market, without the need for training in the industry. Employability skills include not only technical skills but also soft skills. Moreover, since technical skills have become increasingly collaborative and interdisciplinary, soft skills have become important to engineers in the 21st century and it is essential that engineers are trained as T-shaped.

The common view regarding the training of engineers with soft skills is that higher education institutions have an important role in this but higher education institutions do not give the necessary importance to soft skills (Hairi et al., 2011; Berglund and Heintz, 2014; Cukierman and Palmieri, 2014; Sousa and Mouraz, 2014; Hayati and Mir, 2004; Ballesteros-Sanchez et al., 2017; Andersson and Logofatu, 2018; Nicola et al., 2018). Willmot and Colman (2016) stated that responsibility for developing soft skills is not only in higher education institutions but also in other educational institutions, employers, parents, and individuals. However, in this process, it is the duty of higher education institutions to give students the awareness that soft skills are as important as theoretical skills.

In fact, this process represents a mutual relationship. When higher education institutions acquire soft skills to students and prepare them as T-shaped individuals for industry, both higher education institutions and students make a gain from this situation. In other words, while the students graduate with both theoretical and soft skills expected by the sector, higher education institutions find an opportunity to create a qualified brand image by graduating qualified engineers and announce the quality of the education they provide.

When the program outcomes determined by accreditation boards are examined, it is seen that higher education institutions are expected to acquire various soft skills in addition to sufficient technical knowledge about engineering discipline to students. When the curricula of renowned universities in England and the USA are analyzed, it is seen that 7% to 15% of the credit required to graduate devotes to social and humanities elective courses. However, universities in Turkey, reserve at the most 5% credit for social and humanities elective courses. Furthermore, many universities don't reserve credit for social and humanities elective courses and they prepare curricula with only technical courses.

One of the effective ways of gaining soft skills to students in universities is social elective courses. Various content such as methods of developing communication techniques, ethical awareness, and lifelong learning awareness can be offered in these courses. In addition, the inclusion of students in various group works provides the ability to work effectively in interdisciplinary and multidisciplinary teams, as well as the development of negotiation skills. Moreover, when each member of the group is expected to report and explain what they have done in different weeks, they are given the opportunity to improve their writing, speaking, and presentation skills. It would be more beneficial for projects to cover not only one engineering discipline but also different engineering disciplines and even non-engineering disciplines. Thus, students can improve their ability to work with individuals from different disciplines.

In order to provide students with ethical awareness, the business ethics course included in the curriculum of various postgraduate programs can be added in the curriculum, and this course can be explained through real examples to attract students' attention. Various seminars can be organized for students to gain self-confidence and express themselves.

When the studies on T-shaped engineers (Oskam, 2009; Wu et al., 2012; Boehm and Mobasser, 2015; Tranquillo, 2017; Simmons, 2017; Neeley and Steffensen, 2018; Boehm, 2018; Kletzenbauer and Gögele, 2019; King, 2019; Belonovskaya, Kiryakov, Shukhman, Kolga, and Ezhova, 2019) are examined, it is seen that the studies are not sufficient, although it has been a long time since the emergence of this concept. To contribute to these studies, in this study, T-shaped engineers were introduced and the importance of T-shaped engineers for employability was stated. Moreover, for the determination of the soft skills representing the horizontal component of the T shape, program outcomes of accreditation boards, industry expectations, and literature studies were examined. It is observed that soft skills compiled from the literature also include soft skills recommended by accreditation boards and requested from job ads. When soft skills are examined, it is seen that the top 10 soft skills for engineers are communication, teamwork and collaboration, problem-solving, leadership, interpersonal relation, ethics, organizational skill, decision making, time management, creative/innovation respectively, as presented in Figure 6.

Figure 6. Top 10 Soft Skills for Engineers

In the literature, due to the discussion about that soft skills vary according to the sector, soft skills are not clearly identified. In future studies, it is planned to identify the soft skills required for different engineering fields such as industrial engineering requiring more human relations or mechanical engineering requiring more technical skills.

Contributions of Authors

In this study, Melda KOKOÇ created an idea for research, searched the literature, wrote the manuscript, visualize the data, discussed the results and prepared manuscript formatting and editing; Süleyman ERSÖZ created an idea for research, organized the study, contributed to the editing and writing of the paper.

Conflict of Interest

The authors declare no conflict of interest.

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Appendix 1

Soft Skills Compiled from the Literature

Soft Skills	References
Ability to accept constructive criticism	Andersson and Logofatu (2018), Dubey and Tiwari (2020)
Adapting to changes (Flexibility)	Yaacoub, Husseini and Choueiki (2011), Ahmed et al. (2012), Robles (2012), Direito et al. (2012), Abbas et al. (2013), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Taylor (2016), Dubey, Tiwari and Pandiya (2017), Andersson and Logofatu (2018), Wilson and Marnewick (2018), Chaibate, Hadek, Ajana, Bakkali and Faraj (2019), Hartanto, Huda, Fordiana (2019), Gopi Krishna, Suneetha Reddy, Chitra and Yadav (2019). (2019), Ktoridou et al. (2019), Dubey and Tiwari (2020)
Analytical thinking	Sharma and Sharma (2010), Hairi et al. (2011), Ahmed et al. (2012), Maturro (2013), Seetha (2014), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Willmot and Colman (2016), Mohamad, Yee, Tee, Mukhtar and Ahmad (2017), Dubey et al. (2017), Andersson and Logofatu (2018)
Applying the knowledge	Dubey and Tiwari (2020)
Cognitive abilities	Ballesteros-Sanchez et al. (2017)
Communication skill	Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Bayram et al. (2015), Taylor (2016), Willmot and Colman (2016), Mohamad et al. (2017), Dubey et al. (2017), Ballesteros-Sanchez et al. (2017), Andersson and Logofatu (2018), Barros and Bittencourt (2018), Wilson and Marnewick (2018), Chaibate et al. (2019), Hartanto et al. (2019), Gopi Krishna et al. (2019), Ktoridou et al. (2019), Dubey and Tiwari (2020)
Conflict management	Direito et al. (2012), Abbas et al. (2013), Yanaze and de Deus Lopes (2014), Taylor (2016), Willmot and Colman (2016), Andersson and Logofatu (2018), Nicola et al. (2018), Dubey and Tiwari (2020)
Controlling emotions	Makasiranondh, Maj and Veal (2011), Abbas et al. (2013), Naiem et al. (2015), Taylor (2016), Andersson and Logofatu (2018), Gopi Krishna et al. (2019)
Coping skill	Andersson and Logofatu (2018), Dubey and Tiwari (2020)
Cost estimating	Direito et al. (2012)
Courteous	Yaacoub et al. (2011), Robles (2012), Taylor (2016)
Creative/Innovative	Hairi et al. (2011), Ahmed et al. (2012), Direito et al. (2012), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Taylor (2016), Dubey, Tiwari, and Pandiya (2017), Barros and Bittencourt (2018), Wilson and Marnewick (2018), Chaibate et al. (2019), Ktoridou et al. (2019), Dubey and Tiwari (2020)
Critical thinking	Hairi et al. (2011), Yaacoub et al. (2011), Taylor (2016), Ktoridou et al. (2019), Dubey and Tiwari (2020)
Customer management	Maturro (2013), Taylor (2016), Barros and Bittencourt (2018), Dubey and Tiwari (2020)
Decision making	Hairi et al. (2011), Zaharim, Ahmad, Yusoff, Omar, and Basri (2012), Direito et al. (2012), Abbas et al. (2013), Seetha (2014), Naiem et al. (2015), Taylor (2016), Mohamad et al. (2017), Dubey et al. (2017), Nicola et al. (2018), Barros and Bittencourt (2018), Wilson and Marnewick (2018), Chaibate et al. (2019), Dubey and Tiwari (2020)
Detail-oriented	Direito et al. (2012), Yanaze and de Deus Lopes (2014), Dubey and Tiwari (2020)
Ethical awareness	Sharma and Sharma (2010), Yaacoub et al. (2011), Robles (2012), Abbas et al. (2013), Esa et al. (2014), Berglund and Heintz (2014), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Bayram et al. (2015), Taylor (2016), Dubey et al. (2017), Wilson and Marnewick (2018), Chaibate et al. (2019), Hartanto, Huda and Fordiana (2019), Gopi Krishna, Suneetha Reddy, Chitra, Yadav (2019), Dubey and Tiwari (2020)
Goal orientation	Direito et al. (2012), Andersson and Logofatu (2018)
Having common sense	Yaacoub, Husseini, and Choueiki, (2011)
Honest	Hartanto et al. (2019), Dubey and Tiwari (2020)
Individual learning	Naiem et al. (2015), Dubey and Tiwari (2020)
Individual working	Ahmed et al. (2012), Direito et al. (2012), Maturro (2013), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Chaibate et al. (2019), Dubey and Tiwari (2020)
Inquisitive	Yanaze and de Deus Lopes (2014), Dubey and Tiwari (2020)
Intercultural relation	Yaacoub et al. (2011), Direito et al. (2012), Naiem et al. (2015), Taylor (2016)
Interdisciplinary relation (Having different viewpoints)	Yaacoub et al. (2011), Direito et al. (2012), Yanaze and de Deus Lopes (2014), Taylor (2016), Dubey and Tiwari (2020)

Interpersonal relation	Sharma and Sharma (2010), Yaacoub et al. (2011), Ahmed et al. (2012), Robles (2012), Direito et al. (2012), Seetha (2014), Berglund and Heintz (2014), Maturro (2013), Yanaze and de Deus Lopes (2014) , Naiem et al. (2015), Bayram et al. (2015), Taylor (2016), Willmot and Colman (2016), Mohamad et al. (2017), Dubey et al. (2017), Barros and Bittencourt (2018), Wilson and Marnewick (2018), Hartanto et al. (2019), Gopi Krishna et al. (2019)
Interpretation of results	Dubey and Tiwari (2020)
Leadership	Makasiranondh et al. (2011), Direito et al. (2012), Abbas et al. (2013), Maturro (2013), Seetha (2014), Berglund and Heintz (2014), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Bayram et al. (2015), Taylor (2016), Willmot and Colman (2016), Mohamad et al. (2017), Dubey et al. (2017), Ballesteros-Sanchez et al. (2017), Andersson and Logofatu (2018), Nicola et al. (2018), Barros and Bittencourt, (2018), Wilson and Marnewick (2018), Gopi Krishna et al. (2019), Ktoridou et al. (2019)
Lifelong learning	Yaacoub et al. (2011), Robles (2012), Zaharim et al. (2012), Direito et al. (2012), Esa et al. (2014), Berglund and Heintz (2014), Bayram et al. (2015), Wilson and Marnewick (2018)
Listening skill	Direito et al. (2012), Dubey and Tiwari (2020)
Making eye contact	Yaacoub et al. (2011)
Meeting management	Andersson and Logofatu (2018)
Mobility	Yanaze and de Deus Lopes (2014), Chaibate, Hadek, Ajana, Bakkali, and Faraj (2019)
Multitasking management	Yanaze and de Deus Lopes (2014)
Negotiation skill	Direito et al. (2012), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Taylor (2016), Andersson and Logofatu (2018), Nicola et al. (2018), Chaibate et al. (2019)
Organizational skill	Direito et al. (2012), Abbas et al. (2013), Maturro (2013), Ahmed et al. (2012), Sousa and Mouraz (2014), Berglund and Heintz (2014), Yanaze and de Deus Lopes (2014), Bayram et al. (2015), Naiem et al. (2015), Ballesteros-Sanchez et al. (2017), Andersson and Logofatu (2018), Barros and Bittencourt (2018), Wilson and Marnewick (2018), Chaibate et al. (2019), Gopi Krishna et al. (2019)
Patient	Andersson and Logofatu (2018)
Perfectionist	Dubey and Tiwari (2020)
Personal energy	Yaacoub et al. (2011)
Personal integrity	Yaacoub et al. (2011)
Personality development	Berglund and Heintz (2014), Chaibate et al. (2019)
Persuasion	Direito et al. (2012), Andersson and Logofatu (2018)
Planning skill	Maturro (2013), Gopi Krishna et al. (2019)
Positive attitude	Yaacoub et al. (2011), Robles (2012), Seetha (2014), Yanaze and de Deus Lopes (2014), Taylor (2016),
Practical thinking	Bayram et al. (2015)
Presentation skill	Sharma and Sharma (2010), Yaacoub et al. (2011), Sousa and Mouraz (2014), Berglund and Heintz (2014), Naiem et al. (2015), Willmot and Colman (2016), Andersson and Logofatu (2018), Dubey and Tiwari (2020)
Problem-solving	Sharma and Sharma (2010), Hairi et al. (2011), Zaharim et al. (2012), Ahmed et al. (2012), Direito et al. (2012), Abbas et al. (2013), Maturro (2013), Seetha (2014), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Bayram et al. (2015), Taylor (2016), Willmot and Colman (2016), Mohamad et al. (2017), Dubey et al. (2017), Andersson and Logofatu (2018), Barros and Bittencourt (2018), Wilson and Marnewick (2018), Chaibate et al. (2019), Hartanto et al. (2019), Gopi Krishna et al. (2019), Dubey and Tiwari (2020)
Professionalism	Robles (2012), Zaharim et al. (2012), Taylor (2016), Ballesteros-Sanchez et al. (2017), Chaibate et al. (2019), Gopi Krishna et al. (2019), Dubey and Tiwari (2020)
Program management	Hairi et al. (2011), Dubey et al. (2017), Ballesteros-Sanchez et al. (2017), Barros and Bittencourt (2018)
Research skill	Naiem et al. (2015), Dubey and Tiwari (2020)
Results orientation	Maturro (2013), Bayram et al. (2015), Dubey and Tiwari (2020)
Sales management	Sharma and Sharma (2010)
Self-awareness	Direito et al. (2012), Sousa and Mouraz (2014), Berglund and Heintz (2014), Andersson and Logofatu (2018), Gopi Krishna et al. (2019), Dubey and Tiwari (2020)
Self-confidence	Yaacoub et al. (2011), Sousa and Mouraz (2014), Taylor (2016), Andersson and Logofatu (2018), Wilson and Marnewick (2018), Dubey and Tiwari (2020)

Self-management	Yaacoub et al. (2011), Taylor (2016), Barros and Bittencourt (2018), Wilson and Marnewick (2018)
Self-motivation	Yaacoub et al. (2011), Ahmed et al. (2012), Maturro (2013), Berglund and Heintz (2014), Yanaze and de Deus Lopes (2014), Dubey et al. (2017), Andersson and Logofatu (2018), Dubey and Tiwari (2020)
Sharing information	Direito et al. (2012), Dubey and Tiwari (2020)
Sociable / Enterprising	Sharma and Sharma (2010), Direito et al. (2012), Abbas et al. (2013), Maturro (2013), Esa et al. (2014), Wilson and Marnewick (2018), Chaibate et al. (2019), Hartanto et al. (2019), Ktoridou et al. (2019), Dubey and Tiwari (2020)
Stress management	Direito et al. (2012), Yaacoub et al. (2011), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Taylor (2016), Andersson and Logofatu (2018), Nicola et al. (2018), Chaibate et al. (2019), Dubey and Tiwari (2020)
Supervision skill	Abbas et al. (2013)
Systemic vision	Direito et al. (2012)
Taking responsibility	Yaacoub et al. (2011), Robles (2012), Direito et al. (2012, Maturro (2013), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Hartanto et al. (2019), Dubey and Tiwari (2020)
Teamwork and collaboration	Sharma and Sharma (2010), Hairi et al. (2011), Makasiranondh et al. (2011), Yaacoub et al. (2011), Ahmed et al. (2012), Robles (2012), Zaharim et al. (2012), Direito et al. (2012), Abbas et al. (2013), Maturro (2013), Sousa and Mouraz (2014), Berglund and Heintz (2014), Yanaze and de Deus Lopes (2014), Naiem et al. (2015), Bayram et al. (2015), Taylor (2016), Willmot and Colman (2016), Mohamad et al. (2017), Dubey et al. (2017), Andersson and Logofatu (2018), Wilson and Marnewick (2018), Chaibate et al. (2019), Hartanto et al. (2019), Gopi Krishna et al. (2019), Ktoridou et al. (2019)
Time management	Direito et al. (2012), Maturro (2013), Sousa and Mouraz (2014), Naiem et al. (2015), Taylor (2016), Willmot and Colman (2016), Andersson and Logofatu (2018), Nicola et al. (2018), Barros and Bittencourt (2018), Chaibate et al. (2019), Hartanto et al. (2019), Gopi Krishna et al. (2019), Dubey and Tiwari (2020)
Using foreign languages effectively	Yaacoub et al. (2011), Direito et al. (2012), Maturro (2013), Bayram et al. (2015), Naiem et al. (2015), Chaibate et al. (2019)
Using information and communication technologies effectively	Chaibate et al. (2019), Ktoridou et al. (2019)
Using new media	Andersson and Logofatu (2018)
Willingness to improve career	Hartanto et al. (2019)
Willingness to learn	Yaacoub et al. (2011), Ahmed et al. (2012), Maturro (2013), Naiem et al. (2015), Taylor (2016), Ktoridou et al. (2019), Dubey and Tiwari (2020)
Writing skills	Sousa and Mouraz (2014), Bayram et al. (2015), Barros and Bittencourt (2018), Chaibate et al. (2019), Dubey and Tiwari (2020)