Development of an Assessment Model for Soft Skills during Engineering Recruitment Process

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Abstract

The present research work develops a prototype model to assess the soft skills for Engineers to enter the job market, developed based on consolidated psychometrics theory. The aim of the assessment model to evaluate soft skills is to improve the assertiveness of the Engineering hiring process. The theoretical support and guidelines for the elaboration of the model were obtained through a Systematic Bibliographic Review (RBS) with articles published between 2017 and 2022 within the Scopus and Science Direct databases. As a result of the work, a questionnaire with 19 soft skills identified as important for the employability of an Engineer was elaborated. The questionnaire can be used as a tool for data (both qualitative and quantitative) collection, assisting the decision-making process of employers in the Engineering area.

1. Relevance Of The Research

The development of the present research was prompted by an empirical observation by the authors regarding the high turnover of Engineering employees, aligned with a considerably high dissatisfaction of the industries with the hired candidates. The outcome of the research can provide a valuable scientific contribution to the assertiveness of the hiring process for Engineering jobs.

Currently, Engineering graduates present a very robust technical knowledge acquired throughout the course. However, some crucial characteristics for employability, such as rising questions and doubts, vulnerability to demonstrate a need for assistance, assertive communication, and emotional intelligence to deal with, are often taken for granted.

When a company decides to hire an Engineer, the aim is to increase productivity, improve the quality of the company's system and boost processes and business. In this context, how will the organization's goals be met, if the hired person is not the most suitable for the position?

Most of the hiring processes, mainly based on the resumé and an interview, are often not comprehensive enough, as these steps only capture a portion of the candidate’s strengths, weaknesses, and values. This often can lead to an interview that does not reach the recruiter's real objective. Furthermore, without a structured hiring method, the hirer's decisions are at risk of bias and subjectiveness.

The current Industrial Revolution, often referred to as Industry 4.0, influenced both business and education, and some of its targets are to reduce manufacturing time, and increase quality and performance. Therefore, the future of business is highly linked to the Industry 4.0, which consequently demands large investments in skilled labor (Kulkarni et al. 2020). Within this context, Process and Industrial Engineering graduates (Cordeiro et al. 2020) represent the main portion of employees (Piwowar-Sulej 2021), reinforcing the importance of understanding the most important skills.

Industrial Engineers are responsible for the design, implementation, operation, improvement, and maintenance of industrial production systems. As described in the national curriculum guidelines for

Engineering courses of the Brazilian Association of Engineering Education (ABENGE, 2018), these processes involve the most diverse areas within a company, including goods and services, labor, materials, information, technology and energy.

Therefore, the current job market scenario demands both hard skills and soft skills (Tsirkas et al. 2020). According to Débora Campos (2019), the term hard skill is used for technical skills, such as mathematics and logic, whereas the so-called soft skills refer to a set of interpersonal skills.

Different from the hard skills, measuring the development of the soft skills is more challenging (Ginting et al. 2020). However, these skills are indispensable within contexts of constantly changing environment and technologies. The Industrial Engineer, with both Management and Innovation Development roles, is one of the first to experience the impact of market and technology changes (Cordeiro et al. 2020). Especially during global crisis, such as the one caused by the Covid-19 pandemic, the ones who have soft skills stand out (Piwowar-Sulej 2021).

According to Dana Pessach et al. (2020), a company's employees are one of the most important assets of modern organizations. Therefore, large investments are made in this asset to increase success in the workplace.

Consequently, deficient hiring processes incur high costs, both financial and social, due to higher turnover (Pessach et al. 2020). At the same time, identifying personality traits is crucial for hiring the right person for the right job. Guidance about how to assess individual's personality, as well as maps with job characteristics, facilitates the recruitment process and favors a company’s growth (Kulkarni et al. 2020).

For these reasons, this work aims to improve assertiveness during Engineering recruitment, developing a prototype model to be used during the hiring process, with a structured method to assess the soft skills. As the method involves questions answered by candidates, these will show a tendency that will indicate the candidate's aptitude or not for the a given job.

2. Methodology

This work has a methodological framework classified as Bibliographic Research, carried out through a Systematic Bibliographic Review to support the development of the scientific model, which will be explained in the following sections.

2.1 Systematic Bibliographic Review (SBR)

The first step of the research was the Systematic Bibliographic Review (RBS), for the collection of relevant data, followed by a bibliometric analysis to create a robust theoretical basis. The steps of the SBR are detailed in the next sections.

2.1.1 Keyword Selection

The chosen keywords were defined according to each main area that the chosen theme addressed, as shown in Fig. 1, aiming to answer the main research question: How to assess soft skills when hiring for an Engineering position?

After this definition, as shown in Fig. 1, the keywords were gathered in groups and combined prioritizing the use of the words “assessment” and “soft skill”, resulting in 5 research groups, illustrated in Fig. 2.

The graphic asterisk in Fig. 2, which is found in the first group of keywords (*soft skill engineer* assessment*), was used to indicate that variations of the keyword (e.g. plural form) were also accepted.

2.1.2 Definition of Databases and Research Timeframe.

After defining the keywords, the databases Scopus and Science Direct were selected, based on their relevance to the current scientific scenario as a whole and to the research area in particular. Initially, the timeframe from 2017 to 2022 was used. The total number of articles found in this first stage was 19,910 articles, which were exported to the Mendeley software for structuring. Due to the high number of articles found, the years of publication was reduced to articles published between 2020 and 2022, resulting in 8,271 articles. However, this was still a large volume of articles for the scope of the study.

For this reason, two keywords’ groups were eliminated, namely: "soft skill behavioral assessment structure" and "soft skills engineers". These were chosen because "soft skill behavioral assessment structure" resulted in many articles out of the topic scope and "soft skills engineers", has already been encompassed within the study of Campos (2019). The elimination of these keywords, 3,161 articles remained, a number that allowed an effective analysis for the composition of this research.

These Mendeley articles were exported to Excel and some filters were applied to refine the results. The first filter applied was to eliminate any work other than articles published in scientific journals, such as books and congresses. As certain articles were indexed in the two researched databases, a second duplicate filter was applied. The application of these filters resulted in 2,413 articles published between 2020 and 2022, in the three groups of chosen keywords.

The following step of the Systematic Literature Review consisted of reading the titles and abstracts of the 2,413 articles, to evaluate their consistency with the work’s scope. Among all documents, 37 articles met the scope of the study; the others were excluded from the SBR.

Later, the 37 remaining articles were fully read for a deeper analysis and to evaluate which would be used to compose the theoretical basis for the model to be developed. After this step, 7 articles were eliminated for not being fully connected with the topic, and the other 30 were used to support the model proposed. Figure 3 illustrates the steps of articles selection, from the initial 19,910 to the final 30 articles. Refining the articles selection is a key research step, as it provides the necessary bibliographic support for what was developed.

Development of the Assessment Model

The elaboration of the scientific model for this work was based on the books “Manual de Psicometria”, by Tereza Cristina Erthal (1955) and “Theory of Measurement Methods in Behavioral Sciences” by Luiz Pasquali (1996). These classic studies are a reference in Human Behavior and Organizational Psychology, respectively. Therefore, the Questionnaire developed within the model was based on the authors’ guidance on concepts that endorsed the principles of soft skills in work practices.

As a starting point for the questionnaire, six core competences groups, identified by Campos (2019) as the most demanded by the job market for Engineers, were initially taken as a basis. These core competences are shown in Fig. 4.

The soft skills concepts found in the SBR articles complemented Erthal’s and Pasquali’s work, guiding the elaboration of the Questionnaire, based on the psychometrics of how to question human behavior, structured by Erthal (1955), and considering the organizational behavior outlined by Pasquali (1996).

Figure 4 illustrates the six core competences groups identified by Campos (2019), in which the six main competences are located closer to the center of the circle, branching to their respective secondary soft skills. These six core competences are significant for the development of the study, because the entire division of the model started from them.

Table 1 shows an example of the development of the questions for each soft skill based on the the guidance of Erthal (1955):

Erthal's (1955) psychometric format is represented in Table 1, as an example of its use for the elaboration of the model. After reading the article, which is referenced in the column "Author, Year", the main competence discussed in the study is identified, along with the main concept and reflection discussed about such competence. The questions were then based on the concept presented. After the development of the questions, they were sent to 5 psychologists for correction and approval and, subsequently, delivered to the responding students.

In addition to these questions, the insights of Campos (2019) were considered, based on reports from the Organization for Economic Cooperation and Development OECD (2015, 2016a and 2016b) and on the P21 report for 21st century employability (Casner-Lotto and Barrington, 2006).

3. Results: Analysis And Discussion

The results of this work provide a prototype of a model to be used as a tool for Human Resources during a recruitment process to assess the soft skills of Engineers.

The following sections approach the results obtained through the collected data, including the proposed prototype model and the sample characterization. Table 2 illustrates the model developed.

Table 2 presents all the guidelines, subdivided into their soft skills the respective questions. The questions separated by guidelines can be found in the appendix. As for the answers for these questions,

the model proposes the use of Likert scale, with a five-point scale for participants to assess their own performance of soft skills in their work routines, being the five-points scale: Very Often (5); Often (4); Sometimes (3); Rarely (2); Seldomly (1).

Endorsement of the Model

After its elaboration, the model was sent five professionals from the Psychology field. Initially, the model had a total of 109 questions, elaborated by the authors of the present work, based on Erthal's psychometry (1955). After the Psychologists assessment, the scientific model was improved, eliminating questions judged as repetitive, invasive, or even confusing. The final model consisted of 64 questions. The final 64 questions elaborated, and the Likert-type semantic scale were then evaluated and validated by the psychologists.

Conclusion

In agreement with the initial proposition, study fulfilled its aim of elaborating a prototype model to be used as a tool to increase assertiveness during recruitment processes for Engineering. For this, the research counted with the participation of five professionals in the Psychology field.

The design of the model, the importance of the soft skills within the Engineering job market and their relevance through the recruitment process was systematically mapped through a Systematic Bibliographic Review.

The recruitment process for Engineering positions in industries is complex and englobes several variables. When the hiring process relies solely on the diplomas, resumé and the recruiter's impression in a first contact with the applicant, the decision can be biased. It is not uncommon for applicants to try to impress the recruiters with soft skills that are important for the job, but which they do not possess. However, this is not sustainable and results not only in turnover for employees unsatisfaction, but also impacts the company’s performance.

All of this highlights the significance of using a structured model to assist the recruiter in selecting the best profile for the position based on the soft skills with increased assertiveness. The scientific model helps the recruiter to compare their perceptions of the candidate with the results obtained with the application of the model.

Furthermore, the prototype model proved to be robust, as it was elaborated with consolidated psychology from Erthal (1955) and validated by professionals of the area. Another advantage of the model is that it can be applied to any Engineering course, as it is not directed to a specific area.

Finally, a very important outcome of this study is that the Engineering education needs to be continuously innovated and encourage the development of soft skills, showing the importance of these skills in their professional lives. Lower levels of turnover and higher degrees of satisfaction from both employees and employers can only be achieved if the Education is aligned with the Engineering job market’s demands and expectations.

References

1. ABENGE - Associação Brasileira de Educação em Engenharia (2018, January). Proposta de diretrizes curriculares nacionais para o curso de engenharia. Retrieved July 18, 2021, from: http://www.abenge.org.br/documentos/PropostaDCNABENGEMEI_CNI.pdf
2. Alhouli, A. I., & Al-Khayatt, A. K. A. (2020). Assessing the soft skills needs of teacher education Students. *International Journal of Education and Practice, 8*(3), 416-431.
3. Alves, R. B., Kuhnen, A., & Cruz, R. M. (2020). Escala de apego à moradia em área de risco: construção e evidências baseadas no conteúdo. *Saúde em Debate, 43*, 137-151.
4. Apte, M., Bhave-Gudipudi, A. (2020). Cooperative Learning techniques to bridge gaps in academia and corporate. *Procedia Computer Science, 172,* 289-295.
5. Bodolica, V., Spraggon, M., & Badi, H. (2021). Extracurricular activities and social entrepreneurial leadership of graduating youth in universities from the Middle East. *The International Journal of Management Education, 19*(2), 100489.
6. Brown, J. D. (2002). The Cronbach alpha reliability estimate. JALT *Testing & Evaluation SIG Newsletter, 6*(1).
7. Caeiro-Rodríguez, M., Vázquez, M. M., Fernández, A., & Nistal, M. L. (2021). Teaching Soft Skills in Engineering Education: A European Perspective. *IEEE Access, 9,* 29222-29242. http://doi.org/10.1109/ACCESS.2021.3059516.
8. Caggiano, V., Redomero-Echeverría, T., Poza-Lujan, J. L., & Bellezza, A. (2020). Soft Skills in Engineers, a Relevant Field of Research: Exploring and Assessing Skills in Italian Engineering Students. Ingeniería e Investigación, 40(2), 81-91. https://doi.org/10.15446/ing.investig.v40n2.83717
9. Caggiano, V., Schleutker, K., Petrone, L., & González-Bernal, J. (2020). Towards identifying the soft skills needed in curricula: Finnish and Italian students' self-evaluations indicate differences between groups. *Sustainability, 12*(10), 4031._https://doi.org/10.3390/su12104031.
10. Campos, D. B., Resende, L. M. M., & Fagundes, A. B. (2020). The Importance of Soft Skills for the Engineering. *Creative Education, 11*(8), 1504 - 1520. http://doi.org/10.4236/ce.2020.118109
11. Campos, D. B., Resende, L. M. M., & Fagundes, A. B. (2021). *Modelagem fuzzy para diagnóstico de soft skills na Engenharia.* Novas Edições Acadêmicas.
12. Casner-Lotto, J.; & Barrington, L. (2006). *Are They Really Ready to Work? Employers' Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century US Workforce.* Partnership for 21st Century Skills.
13. Chevtaeva N.G., Nikitina A.S., & Vishnevskaya A.V. (2021). Communication culture as a matrix for graduate's "soft skills" development. *Higher Education in Russia, 29*(12), 33-44. http://doi.org/10.31992/0869-3617-2020-29-12-33-44
14. Cordeiro, F. R., Paslauski, C., Wachs, P., & Tinoco, M. A. C. (2020). Production engineers profiling: competences of the professional the market wants. *Production, 30*(129), 2020.

http://doi.org/10.1590/0103-6513.20190093.

15. Erthal, T. C. (1955). *Manual de Psicometria*. Rio de Janeiro: Zahar.
16. Feng, Z., Liu, Y., Wang, Z., & Savani, K. (2020). Let's choose one of each: Using the partition dependence effect to increase diversity in organizations. O*rganizational Behavior and Human Decision Processes, 158,* 11-26.
17. Ginting, H., Mahiranissa, A., Betiki, R., & Febriansyah, H. (2020). The effect of outing Team Building training on soft skills among MBA students. *The International Journal of Management Education, 18*(3), 100423. https://doi.org/10.1016/j.ijme.2020.100423
18. Hadiyanto, H., Nofer, N., Syamsurizal, S., & Muhaimin, M. (2021). Students' soft skills, hard skills, and competitiveness (SHC): a suggested model for Indonesian higher education curriculum*. International Journal of Learning, Teaching and Educational Research, 20*(2), 218-234. https://doi.org/10.26803/ijlter.20.2.12.
19. Hill, B. D. (2011). *The sequential Kaiser-Meyer-Olkin procedure as an alternative for determining the number of factors in common-factor analysis: A Monte Carlo simulation.* Oklahoma State University.
20. Jardim, J., Pereira, A., Vagos, P., Direito, I., & Galinha, S. (2020). The soft skills inventory: developmental procedures and psychometric analysis. *Psychological Reports, 125*(1), 620 - 648. http://doi.org/ 10.1177/0033294120979933
21. Kipper, L. M., Iepsen, S., Dal Forno, A. J., Frozza, R., Furstenau, L., Agnes, J., & Cossul, D. (2021). Scientific mapping to identify competencies required by industry 4.0*. Technology in Society, 64*, 101454. https://doi.org/10.1016/j.techsoc.2020.101454
22. Kulkarni, P. M., Deshpande, A., Arunkumar, P., & Tiwary, V. K. (2020). Personality traits and Industry 4.0-a new dimension for engineering education*. International Journal of Continuing Engineering Education and Life Long Learning*, 30(1), 35-51. http://doi.org/10.1504/IJCEELL.2020.105326
23. Rao P, R. M., Kumar, G. K., Devi, V. R., & Reddy, A. R. C. (2020). Embracing disruption in engineering education. *Procedia Computer Science, 172*, 973-978. http://doi.org/10.1016/j.procs.2020.05.141.
24. Laguador, J. M., Chavez-Prinsipe, N. H., & De Castro, E. L. (2020). Employability skill development needs of Engineering students and employers' feedback on their internship performance. *Universal Journal of Educational Research, 8*(7), 3097-3108.
25. Lucktong, A., Pandey, A. (2020). Perceived-development of soft skills support confidence to obtain a job: a evidence among Science-Tech graduates in Thailand. *Asia-Pacific Social Science Review, 20*(1). 66 -77.
26. Majeedullah, S., Kullu, P., Pranay, P. V. S., Nandula, R., Chandrika, B. S., & Naik, S. M. (2021*).* Improving Skills by Engaging in Student Organizations (A Case Study on Engineers Without Borders). *Journal of Engineering Education Transformations, 34*, 584- 592. http://doi.org/10.16920/jeet/2021/v34i0/157217
27. Nicolaescu, S. S., Florea, A., Kifor, C. V., Fiore, U., Cocan, N., Receu, I., & Zanetti, P. (2019). Human capital evaluation in knowledge-based organizations based on big data analytics*. Future Generation Computer Systems, 111*, 654-667. https://doi.org/10.1016/j.future.2019.09.048

28. OECD. *Skills for Social Progress: The Power of Social and Emotional Skills*, OECD Skills Studies: OECD Publishing, Paris, 2015.
29. OECD. *Skills Matter: Further Results from the Survey of Adult Skills*, OECD Skills Studies: OECD Publishing, Paris, 2016.
30. OECD. *The Survey of Adult Skills: Reader's Companion*, 2nd ed, OECD Skills Studies: OECD Publishing, Paris, 2016.
31. Pantic-Dragisic, S., Söderlund, J. (2020). Swift transition and knowledge cycling: Key capabilities for successful technical and engineering consulting?. *Research Policy, 49*(1), 103880.
32. Pasquali, L. (1996). Teoria e métodos de medida em ciências do comportamento. Brasília: INEP.
33. Pekkanen, P., Niemi, P., Puolakka, T., Pirttilã, T., & Huiskonen, J. (2020). Building integration skills in supply chain and operations management study programs. *International Journal of Production Economics, 225*, 107593. https://doi.org/10.1016/j.ijpe.2019.107593
34. Pessach, D., Singer, G., Avrahami, D., Ben-Gal, H. C., Shmueli, E., & Ben-Gal, I. (2020). Employees recruitment: A prescriptive analytics approach via machine learning and mathematical programming. *Decision Support Systems, 134*, 113290. https://doi.org/10.1016/j.dss.2020.113290
35. Piwowar-Sulej, K. (2021). Human resources development as an element of sustainable HRM–with the focus on production engineers. *Journal of cleaner production, 278*, 124008.
36. REIS, Edna Afonso; REIS, Ilka Afonso. *Análise descritiva de dados.* Relatório Técnico do Departamento de Estatística da UFMG, v. 1, 2002.
37. PEREIRA, André da Silva et al. *Apostila Análise Fatorial.* Universidade de Passo Fundo, 2019.
38. Simmons, D. R., Clegorne, N., Polmear, M., & Scheidt, M. (2021). Connecting Engineering Students' Perceptions of Professional Competencies and Their Leadership Development. *Journal of Civil Engineering Education*, 147(2), 04020015.
39. Surekha, T. P., Shankar, S., Gowda, B. S. (2020). Enhancing the Quality of Engineering Learning through Skill Development for Feasible Progress. P*rocedia Computer Science, 172*, 128-133. https://doi.org/10.1016/j.procs.2020.05.019
40. TOPA, Marcos Aurelio. DA CRUZ, Ivane Carneiro. *Análise Multivariada Como Ferramenta de Gerenciamento de Fornecedores Visando Um Relacionamento Com Vantagem Competitiva.* Projeto de Monografia de Graduação - Universidade Federal do Paraná, 2009.
41. Tsirkas, K., Chytiri, A. P., & Bouranta, N. (2020). *The gap in soft skills perceptions: a dyadic analysis*. Education+ Training.
42. Velakanti, G., & Mathur, A. (2020). *Machine learning approach to find the abilities in a candidate for steady employment in engineering field: A literature survey.* Materials Today: Proceedings.
43. Wisshak, S., & Hochholdinger, S. (2020). Perceived instructional requirements of soft-skills trainers and hard-skills trainers. *Journal of Workplace Learning, 32*(6), 405-416. http://doi.org/10.1108/JWL-02-2020-0029

Tables

Table 1 and 2 are available in the Supplementary Files section.

Figures

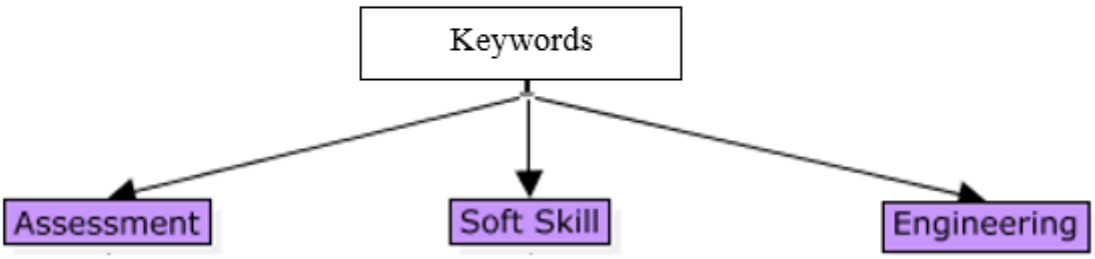

Figure 1

Keywords. Source: Own authorship (2022).

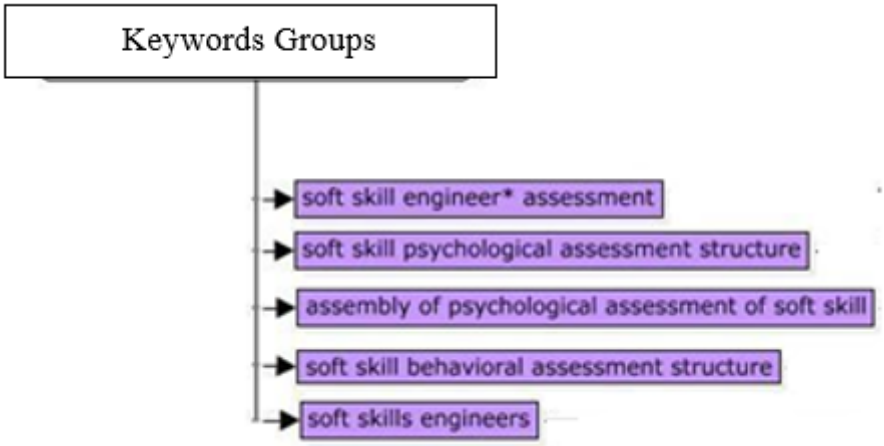

Figure 2

Grupos das palavras-chave utilizados para pesquisa nas bases de dados. Source: Own authorship (2022).

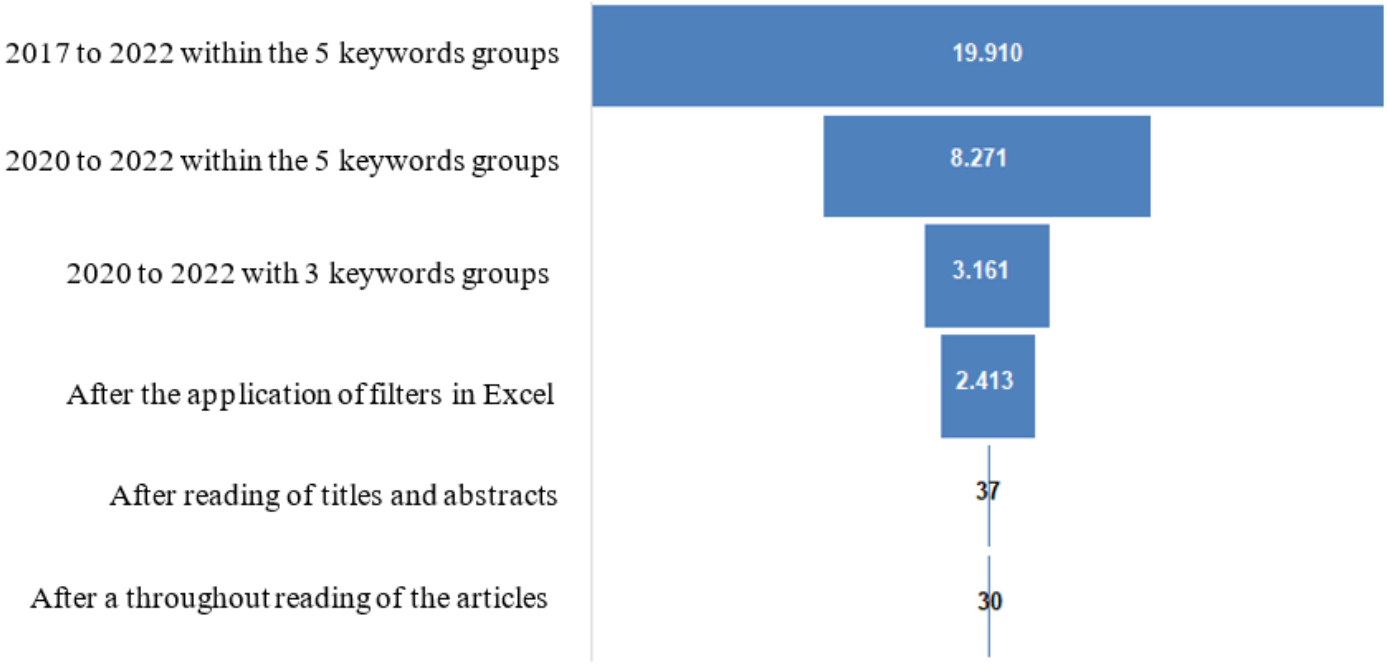

Figure 3

Steps for the articles' selection. Source: Own authorship (2022).

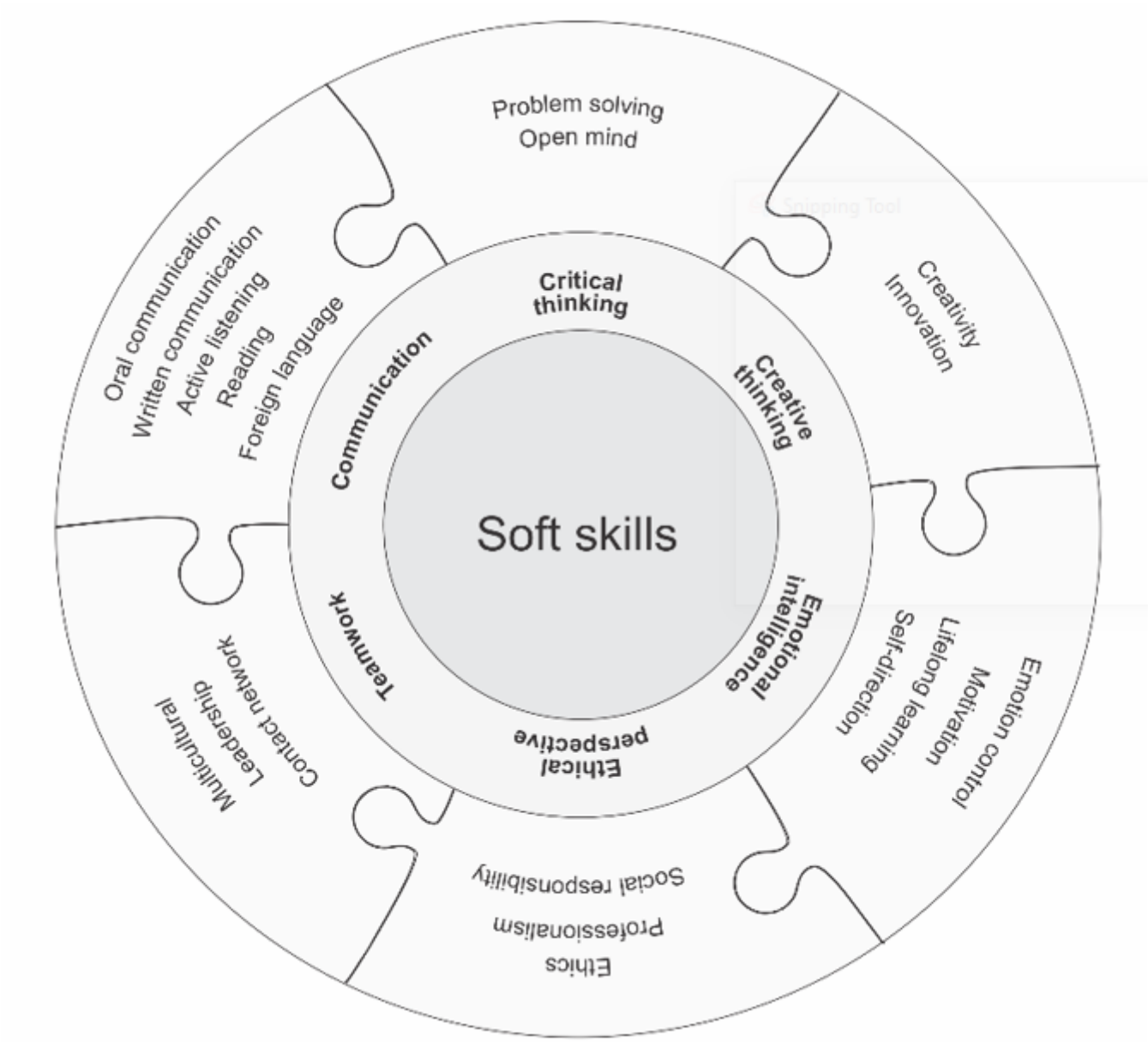

Figure 4

Compilation of the important soft skills for Engineers grouped by their core competences. Source: Campos (2019)

Supplementary Files

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- Table1and2.docx