Project Management in Engineering Education: Providing Generation Z With Transferable Skills

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***Abstract*— Expository approaches in project management education do not seem to be engaging engineering students. Although the students acquire remarkable theoretical knowledge throughout their coursework, they lack transferable competences, such as soft skills, which are scarcely attended in the teaching of project management. Generation Z's characteristics differ from previous generations and should be considered in new project management education approaches and methods. This article reviews the project management competencies, Generation Z profile, and teaching methods trends reported in the literature. It presents a study involving 147 engineering students, through a self-report questionnaire, to explore their profile's self-awareness and compare it with the literature. A correlational study links the Generation Z's personality traits with project management soft skills. Findings reveal interesting personality characteristics of Generation Z engineering students for the project management field. However, this sample showed low recognition of their individualism, less personal relationships, and did not value their creative potential. There were also differences in Electronic, Electrical, and Computer Science engineering students, namely, lower emotional intelligence. Some highlighted traits have a significant effect on critical project management soft skills. Other soft skills were not supported in personality traits. This work suggests implications for re-think educational approaches to Generation Z engineering students.**

***Index Terms*— Engineering education, project management, engineering students.**

I. Introduction

THIS article is an extension of: "A multigenerational approach to project management: implications for engineering education in a smart world" [1], presented in the EDUCON 2020 conference. It extends the literature review concerning project management competencies, Generation Z characteristics, and project management educational methods to suit them. It further explores the study data, namely, by discussing the linkages among engineering educational methods, soft skills, and the Generation Z profile. The article particularly addresses a subset of the sample, made of Electronic, Electrical, and Computer Science engineering students.

Project management is one of the most widely applied transformational management systems and techniques [2], essential for companies to gain competitive advantage and seek success [3]. However, despite organizations defining more of their activities as projects, many projects still fail [4]. Several researchers relate project failure to people factors [5]–[8]. Therefore, besides processes and products, people should be especially considered to foster project effectiveness and success.

Project success appears to be correlated with the project management competencies, which have been increasingly addressed in the literature, e.g., [9]–[12]. In the research field, the focus has been to identify which competencies are most relevant to project success, usually broken down into soft skills, more specifically human and social, and hard or technical skills [13]. Several studies have confirmed that technical skills are essential to the project practitioners, yet not enough [14], [15]. The project professionals need to improve social skills and attitudes, such as communication skills, initiative, teamwork, and leadership, among others [16]. Therefore, one can confirm the companies' growing interest in transferable skills, which refer to experiential and non-subject specific skills that can be used in a broad range of situations [17]. Such transferable skills include leadership, strategic or business management [18], [19], negotiation [20], communication [5], problem-solving [21], and teamwork [22].

The literature enhances the gap that exists between engineer graduates' project management transferable skills and the actual requirements sought by companies and organizations [23]. It also refers to a critical need to combine hard skills with engineering, organizational, collaborative, communication, teamwork, social, and project-based skills [24]. Nevertheless, transversal competences are usually forgotten and neglected in higher education [16]. As such, there is an opportunity to re-thinking project management education and training approaches at Higher Education Institutions (HEIs) [1].

Several authors tried to provide comprehensive lists of transferable competencies [3], [25], [26]. In many cases, such lists are populated with a significant number of competencies. A project manager or a project team member will hardly master all those competencies. Nevertheless, likely only a subset of core competencies is crucial to project success [10].

In addition to acknowledging the lack of desirable, transferable competencies of current project managers, Ashleigh *et al.* [27] refer that there is no clarity on what such transferable skills should be. They also recognize that teaching approaches will be "impacted by a changing student profile, the existence of different learning styles, and the availability of a wider range of instructional models". Therefore, the selection and upgrade of teaching and learning methods and course designs to embody transferable skills must be carefully re-thought, namely, taking into account the characteristics of the current HEI students, which belong to Generation Z.

Generation Z members (Gen Zers) are arriving in the labor market. Once they enter the workforce, they will interact with different generations. Integrating the new engineers in project teams is a challenge that organizations are facing now. What are their primary personality traits that enhance the integration and the development of soft skills in project management? Moreover, what are the most significant gaps in this field? HEIs can play a notable role concerning this issue, namely, by helping students to be more aware of their different behavior when compared with other generations, and to encourage the adoption of teaching and learning methods, techniques and activities to foster transferable skills.

The main goal of this study is to address the following research questions:

- To what extent is Generation Z engineering students self-aware of its traits? Are Gen Zers' perceptions different from the traits described in the literature?
- Are students from Electronic, Electrical, and Computer Science engineering courses significantly different in their emotional and personal profile?
- Is there any association between the personality traits of Generation Z engineering students and the development of the most important soft skills in project management?

With the feedback received, the authors expect to contribute to re-thinking the project management teaching and learning in engineering education.

II. Literature Review

A. Project Management Competencies

The definition of competence is a combination of knowledge, skills, and attitude [14]. Different studies focusing on the competencies of project managers target particular areas, which suggest that competencies differ in importance according to the context, activities, and industries [10]. In the literature, one can find several definitions of competence (e.g., [25], [28], [29]), but the most broadly accepted definition is the combination of knowledge, skills, and attitude, known as 'KSA' [3], [9], [14], [30], [31].

In recent years, many researchers have addressed project management competency, motivated by the belief that project success is strongly correlated with the competencies of project managers. The literature distinguishes three main areas: the context, the project management tools, and the human dimension [18]. The focus on people acknowledges the importance of the human factor contributions to project management [5], [13], [32]. Competencies usually include a set of characteristics, traits, and behaviors necessary for effective performance [10]. Effective project management also requires applying project management skills [9]. The personal competencies of the project manager encompass elements of the manager's attitude and personality characteristics, usually described as 'soft skills' [33]. Soft skills are "competencies that are not directly related to a particular task but are vital in any role because they contribute primarily to the relationships amongst people participating in an establishment" [34]. The literature mentions the main soft competencies for project managers: personal attributes, professionalism, leadership, communication, social skills, and negotiation [15]. Conscientiousness and openness (from the Five-Factor Personality model) are positively correlated with the success of the project manager [35]. Emotional intelligence (EI) ability measures and empathy justify project manager competencies of attentiveness, teamwork, and conflict management [36]. Several authors paid special attention to leadership [11], [14], [15], [22], but there is no consensus concerning the effect of project managers' leadership skills on project success. Zimmerer and Yasin [37] estimated that the reason approximately 2/3 of projects fail is poor leadership. Geoghegan and Dulewicz [11] studied ten leadership dimensions and established a correlation with project success, while in contrast, Turner and Müller [38] found no evidence of such an impact.

Motivated by the need for standards and to draw a path for the project management career development and assessment, other research led to the project management competency framework tools (PMCF) [39], [40]. Such frameworks assist in establishing project management development plans, tailoring project management training and educational programs, and providing guidelines for project managers [31]. The most relevant international project management professional organization, the Project Management Institute (PMI) publishes regularly updated versions of the "Guide to the project management body of knowledge" (PMBOK® Guide) [8], which breaks down project management competencies into ten primary project management knowledge areas: integration, scope, time, cost, quality, human resources, communications, risk, procurement, and stakeholders. The PMI's Project Manager Competency Development Framework (PMCD) provides a framework for the definition, assessment, and development of project manager competence based on the assumption that competencies have a straightforward effect on performance. The International Project Management Association (IPMA), another leading project management professional organization, developed the Individual Competence Baseline, categorizing 46 competency elements into three groups: contextual, behavioral, and technical. IPMA provides its standards in versions for individuals, excellent projects, and organizations. Such frameworks define standards for project managers' certification and imply the competencies that most likely impact the performance of the project manager. The project management competence frameworks have been influenced by professional institutions that prepare, evaluate, and certify project manager professionals [41], establishing standards that influence academic programs [42]. Notwithstanding, PMCFs

TABLE I
MAIN PROJECT MANAGEMENT COMPETENCIES

Assertiveness	Emotional intelligence	Problem-solving
Attention to detail	Emotional resilience	Relaxation
Authority	Experience	Search for information
Cognition	Flexibility	Self-awareness
Commitment	Initiative	Self-control
Communication	Interpersonal relationships	Teamwork
Conceptual thinking	Leadership	Time management
Conflict management	Management	Training
Creativity	Negotiation	Uncertainty
Cultural awareness	Opening	Use of technology
Customer relationship	Organization-solving	Vision
Delegation	Perseverance	Work under pressure
Development of others	Political awareness	

[a.] Adapted from [3], [25].

are more centered on functional and cognitive competencies than social ones.

Several researchers made efforts to build extensive lists of known competencies. Takey and Carvalho [25] distinguished 58 project management competencies, broken down into four clusters of competencies: processes, personal, technical, and context and business. Specifically, the personal cluster consisted of 28 competencies. Alvarenga *et al.* [3] conducted a study that involved 257 project managers with over ten years of experience in project management and identified 28 core competencies. Another review [26] identified 81 competencies in the literature, organized in 11 dimensions: influencing, communication, emotional, contextual, management, knowledge and experience, cognitive skills, professionalism, project management knowledge, and personal skills and attributes. Forty-eight competencies were associated with project success, especially with leadership, emotional competencies, team working, and project management knowledge. However, project managers and team members will barely tame all the competencies included in those lists. Still, probably only a subset of core competencies should be fundamental to project success [10]. Table I enumerates the foremost project management competencies, based on [3], [25].

From the viewpoint of respondents in [3], the three most important skills were communication, commitment, and leadership. Some of the traditional hard (technical) skills appeared in the middle of the table (time management, management, troubleshooting, delegation, organization). The least important competencies were experience, authority, training, use of technology, and technical expertise. These are consistent with other studies reported in the literature [5], [43]–[45].

Currently, projects face a context of change. The people involved have also been changing due to the educational context and the generation they belong to. Project teams tend to be multigenerational, with distinct levels of knowledge, skills, attitudes, and expectations. The following section intends to describe the generation currently found in engineering education: Generation Z.

B. Generation Z

A generation is made of members that share actions, beliefs, politics, values, thoughts, and experiences [46].

Campbell defined a generation as "groups of individuals born during the same time who experience a similar cultural context and, in turn, create the culture. The time in which we are born, and the events that we experience shape us and our culture, and they appear to make a strong bond between members of a generation" [47].

Given their current age, Generation Z is the youngest and the last generation of people in business environments, and so very few of its members have already entered the workforce. Currently, the active workforce is mainly represented by two generations: Generation X (1960-1979), and Generation Y, known as Millennials (1980 - 1994), with Generation Z (1995-2010) [48] now arriving in the workplace. The advancement of technology has contributed to the knowledge and skills gap between different generations. However, the differences are not limited to the technological perspective, but socioeconomic issues differ as well. For instance, Millennials and Gen Zers lived through the financial crash, recession, and slow economic recovery since 2007. During this period, Millennials were already in the workforce, experiencing a degree of precariousness. Generation Z was in a different stage, showing a different perspective on money and labor market, and becoming more entrepreneurial than Generation Y [49]. Gen Zers are more realistic, optimistic, and conscious of opportunities, thanks to technology [50]. Also, because of technology, they are impatient, exhibiting a short attention span [51], but at the same time, they are more pragmatic and analytical about their decisions than previous generations. Their ability to concentrate is short, however, given the diversity of information. They can get interested in various subjects and topics simultaneously. They socialize through the Internet, consume rapidly, are addicted to technology and speed, are interactive, efficient, innovative, creative, result-oriented, individualistic, multitasker, and tend to be dissatisfied. They are self-confident, happy, like social service activities, and are keen on activities that allow them to be creative [52]. They have developed a global perspective and preference for non-standard and personalized works.

Generation Z members do not appreciate teamwork, undertaking it if required [53]. Employers often look for people with teamwork ability [54] and expect them to cooperate and share knowledge to reach their goals. Therefore, different generations must cooperate and understand shared goals, be committed to their job, inclined to provide and ask for help, and trust each other [55].

Gen Zers are independent, resilient, and realize they must work hard to achieve success. They seek a balance between work and family, hoping for a better quality of life than previous generations [50]. They expect to have flexible career paths, want to explore different jobs, and expect competitive salaries [56]. They have a different attitude towards career, being more realistic, optimistic, and conscious of opportunities; hence, they will switch between companies impelled by new experiences and opportunities [50]. It is expected that in the labor market, Gen Zers will be multitasking, creative, efficient users of technology, individualistic, able to create global perspectives, dislike routines, and prefer customized work [20].

Teaching styles must be adapted for Generation Z. The internet and the use of smartphones have had major impacts on teaching styles. Generation Z students are more independent and self-paced [57]. They see the teacher as a facilitator. The answer to any question seems to be within the reach of a simple Google search. However, these students recognize that they need support to process all information they can get. Moore, Jones and Frazier [49] point out recommendations to teach students, most of them from Generation Z. Being a member of a certain generation determines attitudes, different levels of knowledge, and preferences. The prospects for professional development and training differ, as well as the capacity to acquire the skills mentioned before. Thus, in the teaching process, the historical and temporal context should not be neglected, to make the teaching process more appropriate and efficient.

C. Re-Thinking Project Management Transferable Skills Teaching and Learning in Engineering

Several teaching programs have been integrating project management into their curricula, a trend especially identified in engineering programs. Most engineers, when integrated into the workforce, often become supervisors and managers, and are challenged to integrate project teams. Many HEIs are now offering project management as mandatory or elective courses in engineering education.

So far, the engineering education debate has focused on defining what skills and qualities a graduate engineer should master to better face market needs. The regular curricula usually focus on project management technical skills. For the most part, project management education in HEIs has followed a traditional design based on an expository paradigm, usually coupled with exercises to apply techniques and tools [58]. In this case, students' cognitive activities tend to be only processes of repetition of concepts; hence, students do not participate much and are not but receptors of information. This approach does not engage engineering students, who recurrently feel the need for more practical, hands-on learning experiences [27]. Although these students acquire remarkable theoretical knowledge throughout their coursework, they lack transferable competences, such as soft skills, which are not sufficiently attended in the teaching of project management [24]. Nonetheless, companies and organizations expect new graduates to meet their need for transferable skills, resourced with abilities to solve complex technical challenges, working in interdisciplinary teams, and dealing with social and cultural issues [59], which they know to be essential to deal with modern projects. The attainment of only technical skills in HEIs has been stated to be unsatisfactory for graduates to secure jobs and to be effective at the workplace [60]. The emphasis now is laid on instructional approaches that motivate students' active participation in teaching-learning processes for the assimilation of soft skills [61].

There seems to be little research addressing how and which project management competencies and skills should be taught or learned in engineering education [27]. Previous works [62] suggest that engineering students rank problem-solving as a top skill, but closely tied to communication and teamwork abilities. Creativity, good communication skills, and the ability to adapt to change are desired attributes for engineering graduates.

There are different approaches to develop soft skills at HEIs [63]: through stand-alone subjects, embedding it in existing courses, providing support programs, and offering formal and informal activities. An engineering course design can adapt to existing teaching and learning methods that contribute to acquiring transferable skills.

Engineering educators have been experimenting innovative educational practices, like project-based learning (PBL), role-playing activities, computer simulation, agile models, interactive workshops, including pedagogical aspects such as minors and concentrations, other experiential learning opportunities, blended courses, competitive events, and professional certification programs – all in an attempt to strengthen the effectiveness of the learning process of technical and soft skills, and improve students' engagement, satisfaction, and academic results. Various educational approaches focusing on experiential learning or active learning have been considered as a way to overcome some degree of disconnect that seems to exist between the professional engineer and the vision traditional education is based on [64].

One of the most attractive and engaging ways to achieve such a goal is project-based learning (PBL). This approach involves the contextualization of the educational process and the adoption of situated learning [65]. PBL is closely related to group work, planning, communication strategies, and the stimulation of team members' creativity [66]. Students often claim experiences similar to what they will find in the real workplace [58], [67]. In PBL, students work within small groups and are challenged to solve complex and relevant problems that develop their understanding, problem-solving, reasoning, communication, and self-evaluation abilities [61]. Several experiments with undergraduate and master students report improvements in project management transferable skills [6], [24], [27], [58], [68]. González-Morales *et al.* [24] used PBL to challenge groups of 4 to 5 software engineering students to solve real companies' problems. They observed an increase in students' motivation, whereas they were offered practical experiences in supervision, project management, quality control, and decision-making. As a result, students now attain higher academic performance and are better prepared to join the engineering profession.

PBL can also benefit from technology. Ashleigh *et al.* [27] experimented with a blended approach with PBL, aiming to enhance transferable skills and the use of e-learning technology in the process. In this study the authors asked for students' feedback regarding transferable skills and e-learning environments, in which their students were involved. Students claimed for more practical classes and workshops related to the real world and preferred more assessments via project-based and real-life case studies, that would promote interaction and feedback, over abstract examinations. They also showed a preference for exercises and role-playing that simulate real-life situations, as it would encourage self-management and critical thinking skills. Recognizing that the workplace is becoming dominated by technology, the same students admitted

that engaging in e-learning activities would improve their employability, and the use of web-based simulated projects would be helpful to their learning experience. However, they noted that e-learning should deliver adequately designed and relevant content, and that real-time online discussions with the teacher would be helpful. The reported experience, in line with other research reported in the literature, suggests that there is a need to emphasize transferable skills and technical skills in drawing up project management courses. Also, to be motivated students must have the assurance that the skills they are expected to learn are useful and relevant. E-learning can play a more important role in teaching and learning; technology-enhanced learning drives students to participate in the creation of their learning experience actively. To be successful, e-learning requires collaboration within student workgroups. That way, it can drive better communication and a higher quality of thinking and reflection than if learning activities happened in a classroom [69].

Globalization and the fast development of information technologies have increased the use of virtual teams in companies [58]. Using virtual teams in the learning process promotes knowledge sharing and an understanding of human dynamics across functional and cultural boundaries [70]. Several researchers experimented with active and experiential learning with PBL in virtual teams (e.g., [58], [71]), benefiting from the available information technology. They found that students' satisfaction and learning outcomes were enhanced.

Agile models have been often used in software engineering education [72], promoting teamwork and agile procedures, and empowering students to self-manage their time and resources for meaningful learning. Agile models drive participants to develop initiative, creative expression, responsibility, and the ability to organize themselves [73]. Agile and collaborative adoption of Scrum for Higher Education improves the self-learning process, self-motivation, and self-emotion for the learner [74]. Teaching Scrum in engineering courses is an effective way to upgrade and add practical value to professional training [75]. Scrum activities and simulations held in classes seem to contribute to student satisfaction and build collaborative team skills [76], but they are also successfully used in company training [77]. A trendy approach to teaching Scrum is the use of workshops where students use Lego to build a city. The authors have experimented with this approach in classes, confirming high engagement and feedback from students. Such type of experience, also implemented by other authors [34], [78], shows this "workshop format offers several benefits and opportunities, in particular by introducing students to the importance of communication in a project and by offering some learning opportunities that the teacher can react to directly". Scrum enhances "collaboration, collective planning and reflection, and constant communication, can be an excellent project design and management tool in the classroom, to help students develop collaborative skills but also teach them how to be productive members of a community" [76]. The approach helps students learn to listen and negotiate through open communication in project work and get a better understanding of group dynamics. However, the emphasis on teamwork and collective responsibility can somehow mask individual contributions in the learning process, which suggests attention to assessing individual student performance [79]. Besides, not only students but also instructors must be committed to the method; otherwise, there will be low enthusiasm and practice [78]. *EduScrum*, an approach that builds on top of the Scrum project management methodology and active learning, is gaining popularity and has been used in different engineering courses [65], [80], [81]. In general, agile methods, such as Scrum, emphasize action and feedback over project planning and keep gaining ground as tools for effective project management teaching [82]. Taking into account that Scrum is actively used by most computer science and information systems companies [79], the implementation of Scrum into these fields of engineering education is most recommendable.

Another learning approach in engineering education is the use of computer-based simulation, both in class and online. Some are even aligned with the principles of PMBOK. Computer simulations, including competitive games, are generally becoming accepted in engineering education, as they help students develop problem-solving and decision-making skills in a risk-free environment. Several experiences using project management computer simulations have been reported [83], [84], observing that students became more engaged and motivated in project management learning.

Concerning this topic, gamification in the learning process could promote students' engagement. Gamification is the use of "game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems" [85]. Llorens-Largo *et al.* [86] reported several years of applying gamification in ICT engineering courses. The authors enhance that using gamification is not just a matter of adding game-like elements to the learning process. Instead, it involves re-designing the whole course to embody the primary elements of gamification: fun, motivation, autonomy, progressiveness, immediate feedback, and error handling. The study involved recurrent use of videos, which, according to the authors, have a high penetration rate in young people's daily lives. Thus, its features can be exploited in the learning process, boosting educational innovation and making it sustainable.

Role-play is amongst the novel and engaging methods currently used in project management teaching. Role-play is seen as a tool that provides students "an appreciation of the range of issues and problems associated with engineering requirements in a real framework" [87]. This approach has been tried in different contexts, namely online [88]–[91], and involving students in global-based scenarios [83], with multicultural dimensions and aiming to strengthen student's global competencies. Role-playing can create opportunities for students to try multiples roles, including the engineer manager and the project manager. Cobo *et al.* [89] refer to significant advantages of this approach, including better social interaction, communication abilities, self-motivation, and ability to adapt to changing environments, conflict resolution, and negotiation. To be effective, it usually requires social skills, which is why the teacher must adapt and mitigate any risks of rejection from students.

All these methods need a pedagogical project context that promotes experiential learning and that students can fully

understand. The role of students and teachers may change. Teachers tend to assume the role of facilitators and provide guidance to students. Students engage in teamwork and actively participate in the learning process. Throughout this process, teachers need to evaluate technical and interpersonal skills, which require the ability to monitor competencies. Since higher education has been shifting toward competency-based learning, as was especially stressed throughout the Bologna Process, the described methods and related activities must be carefully planned to allow for evidence to support the assessment of individual competencies. In this regard, several authors have shared experiences with PBL approaches, in which they suggest different ways of operationalizing activities and pieces of evidence to assess those competencies (e.g., [24], [27], [58], [92]). For example, in the study presented by González-Morales *et al.* [24], the students involved in project-based learning within the Management of Information Systems course had to follow different activities: project statement, project authorization, development of the project management plan, and Formal technical reviews. For each of these activities, there was a list of skills to learn and evidence for monitoring and assessment. The skills included decision-making, teamwork, conflict management, critical thinking, leadership and supervision, and communication of results, among other skills. Evidence included reports, acts with clients, project deliverables, debates, presentation of documents, customer surveys, student surveys, and others. This experience shows that a proper course design can meet the requirement that competencies should be monitored and assessed.

No single education approach is suitable for all learning styles, and teaching and learning are sure to be impacted by student profiles [27]. Many of the experiences, methods, and activities have been tried to improve the quality of the education of future engineers [59], namely, by embodying soft skills in the project management teaching and learning processes. The wide range of available instructional methods and technologies should provide the tools to upgrade existing engineering courses' design with flexibility to fit the Generation Z profile. In most cases, it is enough to adapt existing common tools and resources, but usually, a lot of extra time and effort is required from educators [92]. The effects of incorporating soft skills teaching in engineering education reported in the literature are generally positive and promising. They have led students to exhibit higher levels of satisfaction and performance, and above all, to be better prepared to meet current companies' requirements and expectations. Upgrading the teaching of project management to prepare Generation Z students is crucial for a smoother transition from college to the workforce and increasing awareness of their motivations [93].

III. Methodology

The study is divided into two stages. It starts with a narrative literature review [94], which aims at identifying a set of recent research works about competencies in project management, Generation Z features and project management in engineering education programs, thus signaling the main concepts and trends in this research field. The second stage is based on quantitative research methodology. To measure the self-perceived personality profile was selected the Big Five personality model, as well as the construct of resilience. Conscientiousness and openness are positively correlated with the project manager's success, as defended by Thal and Bedingfield [35]. These results supported the assessment of the Generation Z profile awareness by the correspondence with the literature [94].

To link the primary Generation Z personality traits that enhance the integration and the development of soft skills in project management, the emotional intelligence (EI) scale was selected. EI is considered a PM soft skill, and some of its dimensions are related to a set of project management soft skills such as self-control, work under pressure, self-awareness, development of others, and interpersonal relationships [2], [25]. A previous study [36] also defends that EI justifies project manager competencies of attentiveness, teamwork, and conflict management. To draw a profile of Generation Z students, regarding their personality traits and their skills, the Big Five personality model, resilience, and emotional intelligence was used. The Big Five Model considers that an individual's personality can be described as a function of five dimensions: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness [95], [96]. Neuroticism is the tendency to experience negative emotional states, to feel stress, and for the individual to see himself/herself and the world in a somewhat negative way. Extraversion is the personality trait that predisposes people to experience positive emotional states, to appreciate the social activity, and to feel good about themselves and the world in general. Openness to experience refers to an individual's propensity to have a broad field of interest, be experience-oriented, be original, and take risks. Agreeableness corresponds to an individual's propensity to relate well with others and be zealously oriented toward others. Conscientiousness represents the degree to which the individual reveals a preference for results-oriented activities and be accurate and persevering. Resilience is a personal, relatively stable positive characteristic that enhances individual adaptation and moderates the negative effects of stress. It implies inner strength, optimism, flexibility, and the capability to positively cope and bounce back when facing situations considered adverse and challenging [97]–[99]. Emotional intelligence can be defined as the individual's ability to perceive and understand their and others' emotions, to access and generate emotions that may aid thinking, and to regulate emotions to promote intellectual and emotional growth [100], [101].

A total of 147 students from various engineering courses (a convenience, non-probabilistic sample) from two major Portuguese public HEI, University of Aveiro and ISEP-IPP, was asked to voluntarily answer a self-report questionnaire in an online form in December 2019. Most students may have had previous contact with learning project management tools, simulation or case studies, and project management software. As part of the project management learning process, most have been involved in teamwork challenges that promote communication, strategy definition, and decision making. Most students were enrolled in Bologna's first cycle of studies

TABLE II

CRONBACH'S ALPHA FOR EACH INSTRUMENT SCALE AND SUBSCALE

		Number of items	Cronbach's alpha	
Emotional Intelligence	Attention to one's Emotions	3	.600	.767
	Sensitivity to Others' Emotions	3	.675	
	Emotional Maturity	3	.611	
	Empathy and Emotional Contagion	3	.682	
	Understanding the causes of one's Emotions	3	.765	
	Self-encouragement	3	.697	
	Understanding of one's Emotions	2	.680	
	Emotional Self-control	3	.668	
Resilience				.775
Personality	Neuroticism	12	.830	
	Extraversion	12	.761	
	Openness to Experience	12	.667	
	Agreeableness	12	.750	
	Conscientiousness	12	.860	

(69.4%). All participants were born after 1995 (51% born in 1999), and 85 were males (57.8%).

Students' personality was assessed through the Big Five model, using Lima *et al.* 's Portuguese 60 items short version of the NEO-Five Factor Inventory – NEO-FFI [102], [103]. The answers were given on a 5-point Likert scale, ranging from strongly disagree (0) to strongly agree (4). To measure the students' resilience, the Resilience scale proposed by Wagnild and Young [98] and adapted to Portuguese adults by Pinheiro and collaborators [104]. This scale is a short version of 13 items with a Likert response scale ranging from totally disagree (1) to totally agree (7). Emotional intelligence was evaluated using an eight-dimension instrument (attention to one's emotions, sensitivity to others' emotions, emotional maturity, empathy and emotional contagion, understanding of the causes of one's emotions, self-encouragement, understanding of one's emotions, and emotional self-control), developed by Rego and collaborators [105]–[107]. The answers were required on a 7-point Likert scale, from 'the statement does not apply to me at all,' (1) through to 'the statement applies to me completely' (7).

Reliability was assessed through Cronbach's alpha. The values (Table II) were all above the cut-point to be considered an acceptable level of internal consistency for all dimensions ($\alpha \geq .60$) [108].

A descriptive and inferential statistics was conducted using IBM SPSS version 25. For the inferential analysis was set a significant level of at least .05. For comparing mean differences between two groups, a set of independent sample *t-test* were computed. To assess the level of association between two numerical variables it was calculated a Pearson product-correlation. To assess the effect size was adopted large effect $r \geq .50$, medium effect $.30 \leq r < .50$ and small effect. $10 \leq r < .30$" [109].

TABLE III

DESCRIPTIVES FOR EMOTIONAL, RESILIENCE AND PERSONALITY PROFILE (n=147)

Measure (scale range)		**Min**	**Max**	**Mean**	**SD**
Emotional Intelligence (0-7)		3.65	6.70	5.24	0.63
	Attention to one's Emotions	1.00	7.00	4.65	1.45
	Sensitivity to Others' Emotions	1.00	7.00	5.52	1.28
	Emotional Maturity	1.00	7.00	4.79	1.40
	Empathy and Emotional Contagion	3.33	7.00	6.07	0.82
	Understanding the causes of one's Emotions	1.67	7.00	5.04	1.35
	Self-encouragement	2.33	7.00	5.59	1.13
	Understanding of one's Emotions	2.00	7.00	5.38	1.15
	Emotional Self-control	1.33	7.00	4.92	1.51
Resilience (0-7)		2.92	6.62	5.25	0.63
Personality (0-4)					
	Neuroticism	0.33	3.67	1.95	0.67
	Extraversion	0.83	3.92	2.57	0.52
	Openness to Experience	1.17	3.58	2.31	0.50
	Agreeableness	0.75	3.75	2.62	0.51
	Conscientiousness	1.08	4.00	2.75	0.60

IV. RESULTS

The means of the different measures were analyzed to characterize the Generation Z students' profile. Regarding emotional intelligence, it is possible to acknowledge that they report higher means of empathy and emotional contagion (M=6.07; SD=0.82), self-encouragement (M=5.59; SD=1.13), and sensitivity to others' emotions (M=5.52; SD=1.28). Participants, on average, revealed less emotional self-control (M=4.92; SD=1.51), attention to one's emotions (M=4.65; SD=1.45), and emotional maturity (M=4.79; SD=1.40) (Table III). Participants reported medium to high levels of resilience (M=5.25; SD=0.63). Regarding personality, one observes low levels of neuroticism (M=1.95; SD=0.67), and medium to high levels of conscientiousness (M=2.75; SD=0.60) and agreeableness (M=2.62; SD=0.51).

To have a broader perspective on how these characteristics might be presented in this generation's gender, differences regarding these measures were computed (Table IV).

The results report that women report statistically significant higher sensitivity to others, empathy and emotional contagion, and agreeableness and neuroticism. On the other hand, men revealed statistically significant higher means of emotional self-control.

The sample was divided into two groups: Electronic, Electrical, and Computer Science engineering students - 'EECS' cluster (n=48; 32.9%), and other engineering courses, namely, Industrial Engineering and Management, Civil, Environmental and Physics engineering students - 'Others' cluster (n=98; 67.1%).

The two groups were compared regarding the dimensions previously referred and it was possible to acknowledge that

TABLE IV

GENDER DIFFERENCES IN EMOTIONAL INTELLIGENCE, RESILIENCE AND PERSONALITY PROFILE

Measure (scale range)		Male (n=85)		Female (n=62)		*t*
		M	**SD**	**M**	**SD**	
Emotional Intelligence (0-7)		5.22	0.63	5.27	0.64	0.413
	Attention to one's Emotions	4.40	1.39	4.98	1.47	2.457
	Sensitivity to Others' Emotions	5.10	1.34	6.09	0.93	5.265**
	Emotional Maturity	4.95	1.30	4.58	1.51	1.570
	Empathy and Emotional Contagion	5.89	0.82	6.32	0.76	3.189*
	Understanding the causes of one's Emotions	5.18	1.34	4.85	1.35	1.449
	Self-encouragement	5.49	1.19	5.73	1.04	1.276
	Understanding of one's Emotions	5.29	1.17	5.52	1.13	1.187
	Emotional Self-control	5.49	1.28	4.13	1.46	6.001**
Resilience (0-7)		5.27	0.63	5.21	0.65	0.602
Personality (0-4)						
	Neuroticism	1.74	0.59	2.25	0.66	5.038**
	Extraversion	2.51	0.53	2.67	0.49	1.855
	Openness to Experience	2.34	0.51	2.28	0.50	0.777
	Agreeableness	2.51	0.51	2.76	0.49	2.894*
	Conscientiousness	2.69	0.58	2.82	0.61	1.329

* p<.001,** p<.001

the 'EECS' cluster presented significant lower means in emotional intelligence score and, also, in dimensions like attention to one's emotions, sensitivity to others' emotions, self-encouragement (Table V).

The two clusters did not exhibit significant difference on average regarding personality dimensions and resilience (Table V).

Table VI presents the correlations between variables. Resilience correlates positively with global emotional intelligence (medium effect; from .30 to .50). Hence, more resilient students appear to have greater emotional intelligence.

Four of the five personality dimensions (extraversion - medium effect; open to experience, agreeableness and conscientiousness - large effect; r≥.50) positively correlate with global emotional intelligence. Therefore, students who show greater extraversion, openness to experience, agreeableness, and consciousness tend to be more emotionally intelligent. Neuroticism negatively correlates with emotional intelligence (medium effect). Thus, students with higher levels of neuroticism tend to have lower levels of emotional intelligence.

Resilience correlates positively with all dimensions of emotional intelligence, except attention to sensitivity to others' emotions and one's emotions. The most resilient students seem to be able to particularly develop their self-encouragement (r=.47), i.e., their ability to self-motivate, to encourage themselves, and to be goal-oriented [105].

Neuroticism correlates negatively with emotional maturity, understanding the causes of one's emotions, self-encouragement, and emotional self-control. Students that

TABLE V

ENGINEERING CLUSTERS DIFFERENCES IN EMOTIONAL INTELLIGENCE, RESILIENCE AND PERSONALITY PROFILE

Measure (scale range)		EECS cluster (n=48)		Others Cluster (n=98)		*t*
		M	**SD**	**M**	**SD**	
Emotional Intelligence (0-7)		5.08	0.67	5.33	0.58	2.382*
	Attention to one's Emotions	4.16	1.46	4.88	1.39	2.890**
	Sensitivity to Others' Emotions	4.98	1.59	5.81	0.97	3.320***
	Emotional Maturity	4.81	1.47	4.80	1.36	0.053
	Empathy and Emotional Contagion	5.92	0.94	6.17	0.72	1.729
	Understanding of the causes of one's Emotions	5.08	1.33	5.04	1.36	0.165
	Self-encouragement	5.31	1.30	5.75	1.00	2.039*
	Understanding of one's Emotions	3.45	0.82	3.67	0.74	1.603
	Emotional Self-control	5.21	1.42	4.78	1.55	1.604
Resilience (0-7)		5.32	0.66	5.24	0.59	0.728
Personality (0-4)						
	Neuroticism	1.82	0.61	2.02	0.69	1.674
	Extraversion	2.51	0.48	2.62	0.51	1.223
	Openness to Experience	2.27	0.46	2.33	0.53	0.690
	Agreeableness	2.53	0.57	2.67	0.48	1.579
	Conscientiousness	2.64	0.59	2.81	0.59	1.564

* p<.050,** p<.010; *** p<.001

TABLE VI

CORRELATION BETWEEN EMOTIONAL INTELLIGENCE AND RESILIENCE AND PERSONALITY (n=147)

		RS	N	E	O	A	C
Emotional Intelligence		.48**	-.36**	.53**	.39**	.50**	.53**
	Attention to one's Emotions	.07	.07	.28**	.29**	.30**	.24**
	Sensitivity to Others' Emotions	.00	.12	.20*	.20*	.42**	.20*
	Emotional Maturity	.31**	-.35**	.19*	.21	.30**	.25**
	Empathy and Emotional Contagion	.27**	-.03	.40**	.24**	.40**	.35**
	Understanding of the causes of one's Emotions	.37**	-.41**	.29**	.09	.22**	.23**
	Self-encouragement	.47**	-.21**	.50**	.23**	.19*	.67**
	Understanding of one's Emotions	.19*	-.02	.25**	.35**	.19*	.21*
	Emotional Self-control	.23**	-.43**	.10	.04	.03	.06

* p<.050,** p<.010; Note: RS= Resilience, N=Neuroticism, E=Extraversion O=Open to experience, A=Agreeableness, C= Conscientiousness

tend to be more neurotic are especially less able to understand the causes of their emotions (r= −.41) and to control their emotions in situations of strong emotional load (r= −.43) (both correlation with a medium-size effect).

Extraversion correlates positively with all dimensions of emotional intelligence, except with emotional self-control. More extrovert students tend to be more empathetic and more

tuned with the people with whom they relate (r=.40, medium effect), and especially they seem to be more proficient at using their emotions to motivate themselves (r=.50. large effect).

Open to experience correlates positively with all emotional intelligence dimensions, except with emotional maturity, understanding of the causes of one's emotions, emotional self-control. Students that have a broader field of interest and are more experience-oriented seem to be more capable of understanding their own emotions (r=.35).

Agreeableness correlates positively with all the dimensions of emotional intelligence, except with emotional self-control. More agreeable students are more sensitive to others' emotions (r=.42) and are better talented to respond empathically to spurs (r=.40).

Conscientiousness correlates positively with all emotional intelligence dimensions, except with emotional self-control. The most conscientious students are also the ones who can best encourage themselves (r=.67).

V. Discussion

Considering the self-assessment of personality traits reported by engineering student participants, it is possible to draw considerations about the results and the Generation Z profile portrayed in the literature, and answer the first question:

To what extent is Generation Z self-aware of its traits? Are Gen Zers' perceptions different from the traits described in the literature?

The sample revealed low levels of neuroticism. The participants self-perceive to be tendentially humorous persons and not dominated by feelings like anxiety, worry, fear, and guilt. However, analyzing by gender, women have higher levels of neuroticism than men. This result is in line with other studies like Lima and colleagues [103]. The theoretical foundations reinforce that these elements are optimistic, more realistic, and more conscious of job opportunities that promote well-being and psychological satisfaction. The personality trait with the highest average was conscientiousness, which corroborates the statement that Generation Z is result-oriented.

The high average agreeableness trait reveals that group tends to be nice and pleasant, or affectionate towards other people, including attitudes such as sympathy and generosity. This characteristic is also highlighted by the results associated with emotional intelligence, with higher values in empathy, emotional contagion, and sensitivity to other emotions, being more evident in women. However, state of the art sees Generation Z members as individualistic, not enjoying teamwork, and even preferring internet communication to personal relationships. Why do not these levels of agreeableness, empathy, and sensitivity to others' emotions promote motivation or interest in teamwork?

The openness to experience scored the lowest average compared with extraversion, agreeableness, and conscientiousness. However, in literature Generation Z is known as one that prefers innovative and creative activities and customized work over repetitive and routine tasks. The results around resilience are in line with the presented literature review, which points to Generation Z with a high level of this trait.

In brief, through their self-assessment results, the participating students are aware of some of their characteristics, as shown by the alignment between the results and the contents sustained in literature, namely the orientation towards results, high resilience and low neuroticism. However, some inconsistencies were also identified. For example, their self-perception regarding the high level of agreeableness is not in line with the literature. It regards them as individualistic and does not see them as placing more emphasis on personal relationships. As referred before, their perception of openness to experience also shows some differences, as literature supports that they are more creative and innovative than previous generations.

Are students from Electronic, Electrical, and Computer Science engineering courses significantly different in their emotional and personal profile?

There was no significant difference regarding the resilience level and the Big Five personality traits when comparing 'EECS' engineering students with other students. These results reinforced the generational approach that defends that the time we are born and grow shapes us and our culture.

The analysis of emotional intelligence dimensions by engineering cluster allowed us to acknowledge that 'EECS' students tend to be less proficient in the domain of their emotional skills. Emotional intelligence, as a global construct, and the dimensions of attention to one's emotions, sensitivity to others' emotions, and self-encouragement present lower values in students from 'EECS' engineering courses.

It seems that these students still need to improve their emotional skills. Indeed, the fact that technology is yet seen as a more technical field that requires more hard competences, emotions seems to be a reality that is deeply antagonistic to this field.

However, these students' challenges will undoubtedly require more and more emotional skills in their professional lives. They will have to increase sensitivity to others' emotions to understand customer's needs to develop a technological solution that satisfies the expectations and creates the desired value. To cope with trial and error, adversity, and frustrations often associated with the technological development process, these students will have to understand their emotions and use them to encourage themselves.

Therefore, there seem to be reasons to deepen efforts to develop this type of skills in 'EECS' engineering students because, more than they can imagine, developing their emotional skills, can be fundamental to their competitive advantage.

Is there any correlation between the personality traits of Generation Z and the development of any important soft skill in project management?

In the frenetic current context known by rapid changes, globalized markets, and constant technological development, projects are becoming increasingly complex and face greater uncertainty. Thus, flexibility and change management are necessary assets for effective project management. The project team, including the engineer members, should be able to solve problems quickly, overcome obstacles, and make decisions throughout the project life cycle.

Literature supports that Generation Z has high resilience indicators and low neuroticism levels, which also converges with the initial results of this research. This fact is very encouraging and important to the project management body of knowledge. It is relevant to know that the future workforce coming to the market will be able to deal with problems, overcome obstacles, and resist pressures in a stressful context, demanding flexibility, and coping with change. Thus, the coming generation can be an important asset within a multi-generational project team regarding the resilience required to effectively lead a project towards its success.

However, as referred to in the literature review, the most recognized project management competency models (developed by PMI and IPMA) are still focused on hard skills; hence, significant research needs to be carried out regarding soft skills.

This research intends to present a set of results that can be addressed to some of the soft skills listed in Table I, namely, opening, interpersonal relationships, development of others, self-control, work under pressure, creativity, emotional intelligence, flexibility, and emotional resilience. From the results presented in Table VI, there are significant correlations between personality traits and specific important project management soft skills.

Focusing on the perceptions of the participating students belonging to Generation Z, the most prominent personality traits were resilience, agreeableness, and conscientiousness. These traits are significantly correlated with a large part of the emotional intelligence dimensions, which are most closely related to self-encouragement, sensitivity to others' emotions, and empathy and emotional contagion. They are important to developing specific soft skills identified as the most important in project management, namely commitment, interpersonal relationship, uncertainty, and perseverance. However, regarding emotional self-control, there was not a significant correlation with the Big Five dimensions, only neuroticism correlates negatively. This finding seems interesting since personality traits cannot assure emotional self-control (the ability to remain calm under tension and to control emotions), so important for teamwork and conflict management. In addition, it should be noted that the effect of the Big Five on emotional maturity (responsiveness to criticism) is relatively low for all dimensions. Knowing how to deal with criticism and different opinions also seem relevant to project management.

Re-thinking project management education to develop soft skills competences in Generation Z

As seen in literature, engineering students tend to rate the ability to solve problems as the most important skill, closely followed by communication, and teamwork skills. They also recognize creativity and change management as desired attributes [62].

The present study shows that these engineering students are aware of their optimism, resilience and conscientiousness. Despite the interesting personality characteristics of participants, such as agreeableness, empathy, and sensitivity, Generation Z is usually described as being individualistic and averse to teamwork. This gap reveals a low level of recognition of their individualism, less personal relationships, and less social skills.

The differences found in 'EECS' engineering students, namely the lower level of EI than others engineering students, enhanced that educational programs still have the focus on technical skills developed by traditional education paradigm built on expository methods and exercises to apply techniques and tools [58] at the expense of soft skills development [24].

Some highlighted Generation Z traits showed a significant positive association with commitment, interpersonal relationship, uncertainty, and perseverance. However, there was no relevant effect of the Big Five dimensions with emotional self-control and emotional maturity.

For these reasons, PM's teaching methods should be re-thinking considering the generation Z profile, the level of awareness of their traits, and the correlation of personality with PM soft skills development. For instance, project-based learning approaches contribute to motivating participants to engage in teamwork activities, involving regular presentations, social interaction, and the use of other forms of communication; also, students tend to be more creative as a team. PBL usually takes some time, requiring high motivation, commitment, result-oriented focus, and resilience.

On the one hand, the learning process benefits from the inherent characteristics of Generation Z students, such as creativity, here boosted by multidisciplinary groups and by non-repetitive tasks, but also resilience, drive for results, and conscientiousness. Project challenges should rely on educational content designed to encourage creativity and innovation. The participants in the survey revealed low levels of openness to experience and were not even aware of this characteristic. On the other hand, PBL could prove effective in building teamwork, collaborative skills, and potentiating communication abilities. Approaches like project Scrum related methods could add opportunities to encourage even better communication, as participants are often required to work as a team, with a high level of empowerment, and further feedback, responsiveness to criticism, and action over strict planning.

Student teams may benefit from balancing gender, as the research shows complementarities between personality and emotional intelligence traits of men and women.

Focusing again on the 'EECS' cluster, the high technical knowledge of these students should be considered as a facilitator to develop soft skills. Several studies suggest that some teaching process grounded in technology, such as e-learning, virtual teams, online role-play, gamification, and computer simulations could improve communication, decision-making, teamwork, conflict management, and problem-solving skills [58], [69], [71], [83], [84], [88].

In Table VI results, the 'EECS' cluster showed a statistically significant difference in sensitivity to others 'emotions. As the genesis of agile models was in software engineering, there is a substantial alignment with the 'EECS' cluster engineering projects. As such, it should be easier to include agile approaches in PM education programs to develop a collaborative environment in teamwork. Since personality traits cannot assure emotional self-control and emotional maturity, as seen in the sample, computer simulation and role-play

methods could also be helpful. Students can simultaneously benefit from their inherent ability to deal with technology and from the opportunity to improve social interaction, conflict resolution, and negotiation techniques, communicating online, and developing global competencies - all so important for effectively managing a project in a global, smart, multicultural, and multigenerational professional world.

To promote project management teaching effectiveness, redesigning course contents and improving the above-referred methods should always be considered.

VI. Conclusion

Generation Z is entering the workforce, and the new engineers will soon be involved in project teams, where they are expected to deliver results under a demanding environment, whereas dealing with older professionals. To what extent are the new graduates prepared to participate in project teams effectively? Which characteristics are more likely suited to deal with today's project management's challenges, and which of their traits should be further nurtured? Are they aware of these traits?

The conducted study was designed to explore the profile of Generation Z engineering students and to understand the extent to which they are aware of their profile and their potential to cope with today's project management challenges of. The 147 engineering students' sample provided interesting results, namely high levels of resilience and conscientiousness, in line with the literature. However, the participants also displayed high agreeableness and low levels of openness to experience suggesting that the sample could be somewhat more inclined to deal with teamwork, which was not very consistent with the literature. In contrast also, they did not seem as potentially creative as expected.

The 'EECS' cluster students self-reported lower levels of EI. However, this result should not be a concern once EI can be developed with training. And, as shown in the correlational study, the most highlighted generation Z personality traits presented a positive effect (large to medium) on several EI dimensions, such as self-encouragement, sensitivity to others 'emotions, and empathy and emotional contagion. Even so, other soft skills were not supported in personality traits, namely emotional self-control.

The results have implications both for educational strategy planning and for practitioners of project management. There is a gap between the professional engineer industry needs today and the vision of traditional education. Such a gap must be overcome using educational approaches that engage, motivate, and satisfy students, take advantage of their ability to use technology, their resilience and conscientiousness to develop teamwork and communication skills.

The literature review identified and detailed a set of current and innovative educational approaches supported in technology, relating them to the development of several competencies, including soft skills. Amongst current educational approaches that could meet such requirements, one can refer to project-based learning, computer simulation, agile methods like Scrum, gamification, and role-playing. So, therefore new project management graduate and undergraduate course designs should consider them.

The study intended to contribute to exploring this subject, addressing it in an original perspective, through measuring student traits with tools such as the Big Five personality model, resilience and emotional intelligence. Furthermore, it meant to better understand the profile of Generation Z, namely their differentiating traits and the way they relate to required project management soft skills.

Further research should follow, namely regarding the adequacy of the mentioned educational approaches to effectively teach project management to engineering students, and to make them acquire and improve the skills the market is and will be asking them.

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