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STEM and the creative and cultural industries: the factors keeping engineers from careers in the CCIs

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Engineers in the Creative and Cultural Industries (CCIs) are underrepresented, despite high demand for their expertise resulting from digitalization. Increasing the quantity of engineers in CCIs has emerged as a policy goal, since experiments have shown that combining engineering and creative abilities enhances productivity and innovation output. It is therefore unsurprising that the high and unmet demand for engineers in CCIs is well documented. However, the factors contributing to them not taking up jobs in these sectors are not well understood. The existing knowledge mostly comes from the analysis of deficiencies within the CCIs, including cultural disparities, skill profiles and economic factors. But why engineers themselves consider CCIs to provide inappropriate career tracks is little understood. The present study aims to bridge this knowledge gap through two main pillars. First, it develops a novel theoretical framework that aims to provide a taxonomy operationalizing the reasons for which engineers do not engage with the CCIs. This framework categorizes the social and economic barriers that keep engineers from pursuing careers in the CCIs. It includes economic factors, educational path dependencies, integration and interest. Second, our study offers preliminary quantitative insights into how the framework operates in practice, identifying key barriers without drawing definitive classifications. This analysis serves to highlight patterns and considerations for the future. The data source used is a survey among 104 university engineering and STEM students. Our results indicate that economic factors, such as poor salaries and job instability that are both prevalent in the CCIs are not the major barriers keeping engineers from the CCIs. They do not feel that educational investment would bear insufficient return. Instead, they feel ill-equipped to integrate into CCIs because of perceived deficiencies in artistic abilities. Furthermore, educational path dependencies for engineers do not necessarily support multidisciplinary education or counseling toward careers in the CCIs. These further exacerbate their worries regarding integration in the CCIs. These issues identified by our exploratory study can be resolved, predominantly because engineering students demonstrate inherent interest in arts and culture. Our research identifies the need for implementing specific changes to promote education and career guidance that span several disciplines.

KEYWORDS

creative and cultural industries (CCIs), engineers, cultural mismatch, labor force and employment, R&D (Research and Development), careers

1 Introduction

The limited representation of STEM professionals, especially engineers in the Creative and Cultural Industries (CCIs) is a recognized barrier to innovation and growth. The UK's Department for Culture, Media and Sports defines the Creative and Cultural Industries (CCIs) as a broad sector encompassing numerous activities. These include advertising, architecture, arts and antiques, crafts, design and fashion, film and video, television and radio, interactive leisure software, computer services, music, performing arts and publishing (DCMS, 2022). Studies highlight that despite the essential role of digital technologies in these sectors, inclusion of engineers remains inadequate (Kwan and Liou, 2018; Wijngaarden et al., 2019). This is partly due to the fact that creative industries focus more on artistic talent than on technical expertise in hiring decisions (Roberts and Wolf, 2018).

Yet, as the digital economy grows, the creative and cultural industries increasingly rely on digital tools requiring STEM skills. Studies highlight the benefits of collaboration between creative practitioners and STEM specialists. The Brighton Fuse project in the UK showed that companies combining creative design with technical skills saw a threefold revenue increase over those focusing solely on creative fields (Sapsed et al., 2015). Despite these benefits, challenges remain in attracting STEM professionals to CCIs (Siepel et al., 2016).

Despite the rise of digital technologies like AI in CCIs, these industries have not fully incorporated the necessary technical skills (Mateos-Garcia, 2018). The UK Government's Industrial Strategy acknowledges the lack of engineers and technologists in key CCI sectors, limiting the adoption of new technologies essential for productivity and innovation (NESTA, 2017). Globally, EY notes that while CCIs employ about 29.5 million people, few are engineers or STEM professionals, leading to a gap between industry needs and talent pool (EY, 2015). The lack of engineers in CCIs challenges global competitiveness. In a knowledge-driven economy, this depends on CCIs' capacity to adopt and lead innovation with new technologies (Rosenzweig et al., 2018). The lack of STEM professionals and engineers in creative and cultural industries (CCIs) is therefore not due to a shortage of demand for technical skills (Li, 2020).

There is, however, notable variation in the extent to which technical skills are utilized across the CCIs. Specifically, the portion of the DCMS's classification of CCIs that falls under the "Arts, entertainment and recreation" Standard Industrial Classification (*SIC*)—including sectors such as performing arts, music, and crafts—likely requires less engineering expertise than the CCI subsectors categorized under the Information and Communication *SIC*, which includes IT and media. Nonetheless, the underrepresentation of engineers is a distinct characteristic across both of these CCI subsets. Tangible evidence supports this HESA (2022). Among the UK's engineering graduates in 2021, only 1% entered the "Arts, entertainment and recreation" sector, compared to 11% of biology graduates. These proportions cannot be explained solely by the higher number of engineering graduates compared to biology graduates. In 2022, for instance, 60,345 students graduated with an engineering degree, while 36,175 graduated with a biology degree (StandOutCV, 2024). Applying the 2021 employment proportions to these 2022 numbers (while not strictly comparable, it is the best available estimation) suggests that roughly 600 engineers and nearly 4,000 biologists entered the "Arts, entertainment and recreation" sector. This indicates a systemic barrier preventing engineers from joining the CCIs (Mateos-Garcia and Bakhshi, 2016). Similar trends appear in the more technical subset of CCIs, specifically within "Information and Communication." 7% of 2021 engineering graduates work in this subset, a lower proportion than the 11% of physics graduates and comparable to the 6% of geography graduates in the same sector.

In addition to the problem of underrepresentation, the CCIs suffer from a lack of diversity when it comes to educational backgrounds. 46% of creative graduates work in the CCIs in the UK (Bloom, 2021). In contrast, even hardcore technical sectors like manufacturing and aerospace are more diverse than this. 18 to 40% of their workforce is made up of technicians, keeping lots of positions open for professionals with non-technical backgrounds (Roberts and Wolf, 2018).

Structural obstacles, such as cultural and educational segregation, hinder STEM professionals' participation in CCIs. Historically, creative and technical fields have been separate, leading to limited educational overlap due to institutional biases (Sapsed et al., 2015). Consequently, STEM graduates may not consider careers in CCIs, and creative graduates may lack needed technical skills (Siepel et al., 2016).

Poor alignment of skills exacerbates the gap. CCIs often lack clear roles or career paths for engineers, despite growing demand. The absence of role models, mentoring, and institutional support limits STEM graduates' ability to transition (Guile, 2009). Additionally, the freelance nature of creative sectors may not appeal to STEM professionals used to structured careers (Henriksen et al., 2015).

Beyond integrating engineers, creating work environments that encourage cross-disciplinary collaboration is essential. Diverse teams yield more innovative outcomes, yet many CCIs operate in silos lacking interdisciplinary collaboration (Bilton, 2017). Industries must foster environments promoting collaboration between STEM professionals and creative teams.

Policy interventions are proposed to encourage cross-disciplinary education and training. Strategies include reorganizing educational programs to integrate STEM and creative fields and offering incentives for creative enterprises to hire more engineers (Sapsed et al., 2015). Promoting role models and mentoring could help STEM professionals see career paths in CCIs (Henriksen et al., 2015).

Despite policy recommendations, there is a lack of literature on how engineers engage with CCIs, including their interests and the factors discouraging them. Understanding STEM graduates' perspectives is essential to determine if changes like educational reform or new career paths will succeed. A personal viewpoint is crucial when creating strategies to link STEM knowledge with creative industries.

This study aims to address this disparity by focusing on a key group: university students in engineering and STEM fields about to enter the workforce. Pre-entry career choices are influenced by initial views on job responsibilities and prospects (Gambardella et al., 2021). Early decisions are often shaped by expectations of job stability and self-perception rather than actual market conditions (Tomlinson, 2012). This suggests that avoiding CCIs may stem from misunderstandings or lack of familiarity. We aim to understand what influences students' career decisions, particularly regarding CCIs.

The students surveyed are in full-time education (including those in Masters' programs), so even if they pursue paid activities to complement their incomes, they are yet to fully immerse themselves in the pursuit of their definitive careers. We aim to identify factors discouraging this group from pursuing careers in

the CCIs through a voluntary survey. This approach allows us to provide a preliminary analysis of their views before fully committing to a career path, offering a fresh look at the entry barriers that have not been deeply explored to date. At the same time, the objective of this study is not to classify the barriers from most to least important. Instead, we aim to operationalize our theoretical framework (presented in Section III below) with exploratory evidence.

This study uses constructs a taxonomy to operationalize the challenges that young engineers face when considering careers in CCIs: Interest, Economic factors, Integration, and Educational path dependencies.

Interest (or the lack thereof) is crucial. While engineering students often engage with the arts in high school, this rarely influences their career goals. However, our findings show a strong link between participation in artistic activities and enthusiasm for CCIs, challenging earlier studies (O'Brien et al., 2016). Economic factors are documented to be significant barriers for entering the CCIs (Brook et al., 2020). Nevertheless, our surveyed students did not view low wages or job instability as major concerns. The integration of skills and individuals into the CCIs is also examined. Students are confident in technical skills but express concerns about adapting to creative environments and lacking necessary artistic skills, posing psychological barriers. This aligns with studies showing engineers feel uncertain about dynamic, innovative work settings (Kaszynska and Crossick, 2016). In terms of educational path-dependency, students believe universities should offer more cross-disciplinary courses to prepare them for CCIs, supporting the need for integrative educational models (Kohlgrüber et al., 2021). Enhancing connections with creative industries could improve career prospects.

The rest of this paper is organized as follows. In Section III, we present our theoretical framework, based on insights from the previous literature, including its testable hypotheses. In Section IV, we present our survey and analysis methodology, as well as the data collected. In Section V, we present the results from our research, and in Section VI, we discuss the conclusions, their policy implications, and their influence on promoting R&D in the CCIs.

2 Theoretical framework

Our theoretical framework emphasizes the dimensions of interest, integration, economic factors, and educational path dependencies because these are elements that can be directly influenced by educational strategies and employment policies within the creative and cultural industries (CCIs). By focusing on these dimensions, we target modifiable factors that play a significant role in shaping future engineers' decisions to engage with the CCIs.

These four dimensions are susceptible to change through relatively straightforward interventions. Educational institutions could—at least in theory—redesign programs to enhance interest and integration and to address issues with educational path dependencies (Holley, 2017; Renninger and Hidi, 2015), while CCIs can modify employment strategies to integrate engineers better and to address economic concerns (Pennill et al., 2022), even though this latter strategic aim is undeniably more complex than the former. This alignment with actionable strategies makes these dimensions critical for understanding and influencing engineers' career decisions.

Our selection of dimensions to focus on does not mean or imply that others are irrelevant. Quite the contrary—multiple other important factors play a role in engineers' career choices and in their decisions to potentially avoid the CCIs. These may include technological path dependency, peer effects, and job availability. Nevertheless, these are exogenous and less amenable to immediate influence. Technological path dependency involves entrenched systems and standards that require long-term, systemic change to alter (Djelic and Quack, 2007). Peer effects are rooted in broader social and cultural contexts that are challenging to modify through targeted strategies (Calvó-Armengol et al., 2009). Job availability is dictated by market forces and economic conditions beyond the control of educational and industry stakeholders (Blustein, 2019).

By excluding these exogenous factors, our framework maintains a practical focus on elements that can be directly impacted. This approach is supported by the career development literature, which emphasizes the effectiveness of targeting modifiable variables to facilitate career transitions (Lent and Brown, 2013). Moreover, it acknowledges the limitations of attempting to influence factors that are resistant to change due to their complexity and external nature (Hesmondhalgh, 2018). This targeted approach provides a practical framework for stakeholders to encourage greater participation of engineers in the CCIs, ultimately bridging the gap between technical expertise and creative industries. In the following subsections, we present each of the four pillars of our theoretical framework.

2.1 Interest

Interest significantly impacts career trajectories, especially for students about to enter the professional world. Interest goes beyond mere curiosity; it involves a natural drive to engage in a particular field or profession, shaped by personal inclinations and external influences like education and institutional guidance. Engineers' interest in the creative and cultural industries (CCIs) is vital as it determines their consideration of CCIs as a viable career path.

Research on career decision-making highlights the crucial role of interest in shaping professional paths. Holland's career choice theory (Holland, 1997) indicates that people tend to thrive in jobs that match their interests, leading to greater job satisfaction and motivation. Lent et al. (1994) explore the impact of Interest on self-efficacy and outcome expectations in career development. The results align with O'Brien et al. (2016), showing that young professionals' career goals are heavily influenced by their early exposure to intriguing subjects. Engineers may not easily see the motivation to engage with the CCIs. Engineering programs have traditionally focused on sectors like manufacturing, software, and infrastructure, offering conventional career paths (Jones et al., 2017). As a result, engineers might not have much early exposure to creative industries or the specific jobs available in those fields. This is a problem because interest includes both the initial attractions for students and the career paths they discover.

Awareness is crucial for developing career paths. Evidence indicates that people proactively pursue opportunities in areas that already capture their interest, so strengthening a beneficial cycle in which interest stimulates awareness, and awareness in turn intensifies interest (Bandura and Cervone, 1986). Students interested in a field are more likely to seek internships, networking, and industry exposure related to that field (Tomlinson, 2017). If students do not know about

job opportunities in CCIs for engineers, their interest in the arts or creative industries may not lead to active career exploration. This knowledge gap can be a significant hurdle for engineers. Unlike finance or IT, where career paths are clear, engineers in CCIs face less predictable prospects due to the multidisciplinary nature of their work. Bakhshi (2022) argues that, despite the creative economy's reliance on digital technologies, many engineers may overlook opportunities to apply their skills in this area. Engineers with personal interests in creativity may overlook CCIs as a viable career option due to a lack of awareness.

A key factor influencing interest is how university education and socialization shape students' perceptions of suitable professions. Universities often significantly influence career standards, leading to what some call "career indoctrination." Research shows that the structure and focus of higher education programs can subtly discourage students from exploring non-traditional career paths (Tomlinson, 2017). Engineering curricula often focus on traditional career paths, like corporate jobs, which can reduce interest in alternative fields such as the CCIs (Jones et al., 2017). Academic programs promote logical reasoning and specialized knowledge, which may not always fit the dynamic and less organized nature of the CCIs (Hesmondhalgh and Baker, 2011). "Indoctrination" can limit the professions engineers consider, as many students believe that creative fields are outside their scope. Evidence shows that university career counseling and job placement services often overlook the potential for STEM graduates in the creative industries (Throsby, 2001). This can worsen the decline in interest by creating the impression that CCIs are not serious or financially viable career options for engineers.

Institutional structures significantly influence interest, beyond just individual or psychological factors. Interest and institutions significantly intersect in shaping career paths, as institutions can either promote or suppress interest in certain fields. Higher education institutions and programs significantly shape students' perceptions of what is achievable or desirable. Institutions create an environment that sparks student interest by focusing on specific disciplines (O'Brien et al., 2016). Educational institutions that promote interdisciplinary learning or offer courses linking engineering and the arts can spark interest in CCIs by showing students the potential for collaboration across various sectors. Research shows that students are more likely to develop career interests in fields where they can experiment, participate, and see their skills in action (Banks and Oakley, 2016). Separating engineering from creative fields in educational institutions may limit students' interests, reinforcing the idea that engineering and creativity are unrelated careers. Institutions can shape interest by exposing individuals to role models and providing career guidance. Universities highlight alumni who successfully blend technical skills with creative industries, demonstrating the viability of these career paths and increasing interest (Kaszynska and Crossick, 2016). Lack of institutional support can result in low interest in CCIs among engineering students, despite their personal interest in creativity.

Given the above, the testable hypotheses from the "Interest" pillar of our framework are the following.

Engineering students know little about career opportunities in the creative and cultural industries (CCIs). This hypothesis examines if engineering students are unaware of potential positions in the CCIs due to limited exposure or promotion during their education.

Engineering students who are personally interested in creativity and the arts are more likely to pursue careers in CCIs. This hypothesis examines if students with a natural interest in creative activities, like arts-related extracurriculars, are more likely to consider careers in CCIs.

2.2 Educational path dependency

Educational path dependency, the second dimension of our framework significantly impacts the career paths of university students, particularly in STEM fields. Educational institutions, like universities and colleges, shape students' career choices, encouraging traditional paths or allowing exploration of unconventional fields, such as creative and cultural industries (CCIs). Literature shows that institutions actively guide career development. They influence students' career choices and feasible paths through curricula, career services, extracurricular activities, and job market exposure.

Higher education institutions create environments for students to develop their career goals. Evidence shows that institutional frameworks often create rigid paths for students, particularly in fields like engineering, where the curriculum heavily focuses on technical skills and traditional career routes (Tomlinson, 2017). Engineering programs are known for strict curricula focused on problem-solving, applied mathematics, and physical sciences, offering few chances for interdisciplinary exploration (Adams et al., 2011). As a result, many engineering students are steered toward conventional careers in technology, infrastructure, or manufacturing, rarely encouraged to consider alternatives like the CCIs.

Research supports the idea of institutional inflexibility, noting that universities and colleges often reinforce traditional career paths through curriculum design and their professional networks (Tomlinson, 2017). Engineering students typically need to progress in their careers in fields that align with their technical education. Lack of institutional support for alternative pathways that blend technical skills and creativity limits students' career perspectives (Mellors-Bourne et al., 2011). Research also shows that universities typically organize job fairs, internships, and co-op programs aimed at industries with a clear demand for engineers, including technology companies, industrial firms, and government organizations (Jones et al., 2017). This focus on mainstream professions restricts opportunities for students to explore non-traditional sectors like the CCIs, where their skills are also needed but less promoted.

Educational institutions can greatly enhance students' professional opportunities by incorporating adaptability into the curriculum and providing exposure to various career paths. Evidence shows that interdisciplinary curricula, exposing STEM students to arts, humanities, and social sciences, can enhance innovation and creativity (Henriksen et al., 2015). Educational institutions encouraging engineers to take elective courses in digital media, design, or entrepreneurship provide valuable opportunities for students to explore the practical use of their technical skills in creative fields. Bakhshi et al. (2013) argue that multidisciplinary education is essential for preparing students for the demands of the creative economy, where technology and creative production are increasingly linked. Integrating interdisciplinary opportunities into STEM programs helps students recognize the importance of creative industries and may inspire them to pursue careers in these fields. Despite data showing the benefits of interdisciplinary exposure, many engineering programs

remain compartmentalized, limiting students' interactions with other fields (Jones et al., 2017).

Studies show that extracurricular activities are vital for expanding students' professional opportunities. Academic institutions hosting interdisciplinary hackathons, workshops, or design challenges allow STEM students to collaborate with peers from diverse creative fields (Kaszynska and Crossick, 2016). These programs educate engineers on job opportunities in the CCIs and develop essential skills like collaboration, innovative problem-solving, and adaptability needed in these industries. Schools that promote cross-disciplinary experiences can change how students view their career opportunities. Job fairs, career counseling, and mentorship programs significantly shape students' professional ambitions. Many universities have career services that organize job fairs and connect with industry partners for internships and jobs. These events usually focus on established industries with a clear demand for engineering graduates, like finance, technology, or government, thereby reinforcing traditional employment pathways (Tomlinson, 2017). Research shows that without representatives from creative sectors or a focus on opportunities in CCIs, students are less likely to see these industries as viable career paths (Banks and Hesmondhalgh, 2009).

Mentorship programs in universities often focus on pairing students with professionals in traditional engineering roles, reinforcing the idea that engineers only belong to established industries. Throsby (2001) states that the absence of role models or mentors who connect STEM and creative industries leads to students being unaware of the possibilities for merging technical and creative skills. Without role models who have taken unconventional career paths, students are less confident in pursuing careers outside traditional engineering. Interest and institutions intersect clearly: institutions shape students' views of the job market and can spark interest in certain careers through relevant exposure and support. Institutional inflexibility might deter engineers from careers in the CCIs, but educational flexibility could significantly influence this.

Here are the testable hypotheses from the "Educational path dependencies" pillar of our framework:

Institutional inflexibility in STEM curricula limits access to interdisciplinary courses, yet engineering students would gladly enroll in artistic and interdisciplinary options if offered. This hypothesis examines whether engineering students would participate in interdisciplinary and artistic coursework if such options were part of their undergraduate programs, regardless of their personal interest. It examines if their openness to opportunities differs from their natural creative interest.

Academic institutions play a key role in communicating unconventional career opportunities in CCIs to engineering students. This hypothesis examines how inadequate institutional promotion of non-traditional career paths, like CCIs, affects engineering students' likelihood of considering these fields. This highlights the importance of career counseling and job fairs in shaping students' career thoughts.

2.3 Economic factors

Economic factors are a key aspect to our framework, relating to the professional choices students, particularly in STEM fields, must consider when choosing a career. They play a key role in understanding why engineers hesitate to enter the creative and cultural industries (CCIs), as their career choices are often shaped by concerns over the financial returns on their education and professional investments. For STEM students, the focus on economic factors is vital due to the significant time and resource costs of earning their degrees, with the expectation that these investments will lead to stable, well-paying jobs.

Investing in education, particularly in STEM fields, requires significant personal and financial commitment from students. STEM degrees require more coursework, lab work, and higher tuition due to specialized equipment and instruction (Carnevale et al., 2011). Students in STEM fields expect a higher return on their investment (ROI) than those in other disciplines. Research shows that STEM graduates usually earn higher salaries than those in the humanities or social sciences (Sullivan et al., 2018). Investment is particularly relevant for STEM students, as their education is seen as both a path to personal satisfaction and an important economic decision.

Scholarly literature highlights the greater importance of investment for STEM students over those in other fields. The cost of a STEM and engineering degree is often higher. This phenomenon stems from direct expenses like higher tuition for specialized courses and opportunity costs, as STEM programs often require longer completion times and unpaid internships (Kokkelenberg and Sinha, 2010). STEM and engineering students often face tougher academic demands, leaving them with less time for part-time jobs or extracurricular activities that could help cover their education costs (Carnevale et al., 2011). STEM students expect their degrees to lead to better financial rewards through stable, high-paying jobs and opportunities for career growth.

Job security is vital for STEM students, as many are drawn to these fields because of the strong demand and stable employment opportunities. Studies show that STEM graduates have lower unemployment rates and higher lifetime earnings than those in non-STEM fields (Rothwell, 2013). Students often choose engineering or STEM fields over less lucrative areas like the arts or social sciences due to the desire for financial security (Mellors-Bourne et al., 2011). The strict academic and financial demands of STEM degrees create higher expectations for corresponding financial rewards. Students in STEM fields may avoid career opportunities without clear financial benefits or those with significant uncertainty regarding salary or job stability, common issues in creative industries (Throsby, 2001).

Creative and cultural industries are seen as financially unstable, with lower wages and less job security than traditional engineering sectors (Menger, 1999). Research shows that many positions in the CCIs are freelance or short-term contracts, unlike the full-time, stable jobs engineers expect (Hesmondhalgh and Baker, 2011). Employment in the CCIs is unstable, marked by project-based work, unpredictable income, and limited benefits such as health insurance or pensions (Banks and Hesmondhalgh, 2009). Economic uncertainty can deter STEM graduates who invested heavily in their education for a stable and rewarding career. Engineers must assess if the financial and personal rewards of a creative industry outweigh the economic risks.

This examination of economic factors is linked to professional employment security. Engineering professionals are drawn to sectors with high demand for their skills and clear career advancement opportunities. The creative industries are dynamic and innovative but often lack clear career paths for engineers, especially those unfamiliar with the profession's multidisciplinary aspects (Kaszynska and Crossick, 2016). The lack of a clear career path in the CCIs may deter

engineers from pursuing opportunities in the industry, as they might not perceive a worthwhile return on their investment.

Here are the testable hypotheses from the "economic factors" pillar of our framework:

Engineering students view careers in CCIs as less financially rewarding than those in traditional engineering fields. This hypothesis explores if engineering students avoid CCIs as career options because they perceive lower salaries and financial instability.

Concerns about job security hinder engineering students from entering CCIs. This hypothesis explores if job security worries linked to freelance and project-based work in CCIs are a major barrier for engineers.

2.4 Integration

Integration, the final dimension of our framework, emphasizes cultural compatibility and the merging of engineers' and STEM professionals' skills in the creative and cultural industries (CCIs). This aspect looks at engineers' views on the alignment of their technical skills with CCIs' needs and the inclusivity of these sectors for professionals from technical backgrounds. Understanding Integration is crucial, as cultural and professional differences between engineers and CCIs can pose significant challenges, regardless of interest or financial incentives.

Engineers considering careers in the CCIs face a significant challenge in applying their technical skills, rooted in logic, mathematics, and problem-solving, to industries that prioritize creativity, adaptability, and more fluid forms of innovation (Kaszynska and Crossick, 2016). Research shows that while the demand for digital skills in CCIs has risen, there remains a belief that technical proficiency does not align well with creative work environments. Many engineers might see their skills as overly specialized or too rigid for the dynamic, multidisciplinary nature of creative industries.

Studies on digital transformation in the Creative Industries show that incorporating technology into creative processes is increasingly essential. Film production, game design, digital media, and virtual reality require strong technical skills in software development, artificial intelligence, and data analytics (Bakhshi et al., 2013). Engineers have valuable skills, but these opportunities may not be clear to engineering students. This creates a gap between the demand for technical skills in CCIs and engineers' perceptions of their ability to contribute significantly.

Another important issue is using engineers' problem-solving and project management skills in creative projects. Engineering professionals are educated to work in organized environments with clear outputs, deadlines, and criteria for success. Creative industries focus on flexible timelines and iterative processes for experimentation and adaptability (Jones et al., 2017). Engineers might find the lack of clear structure daunting, as it challenges the established roles and procedures typical in conventional sectors. Incorporating engineers into CCIs involves applying technical skills and adapting to various work cultures and standards.

The second aspect of Integration involves the cultural compatibility between engineers and the creative industries. Engineers often notice a significant cultural gap between their rigorous, objective training and the subjective, interpretative nature of creative work. The gap in values and methods can discourage engineers from considering careers in CCIs, despite their highly relevant skills. Hesmondhalgh and Baker (2011) suggest that CCIs have traditionally been seen as domains for "creatives" like artists, designers, and writers, prioritizing intuition, creativity, and non-linear thinking over the analytical approaches favored by engineers. Engineers may feel alienated in these environments, unsure how their skills fit with the collaborative dynamics of creative teams. The engineering culture often prioritizes accuracy, efficiency, and optimization, which can clash with the experimental and iterative nature of many creative fields.

The lack of cultural compatibility can worsen due to poorly defined structures or responsibilities in many CCIs meant to integrate technical professionals. Research shows that while CCIs increasingly rely on tech innovation, many organizations still lack the internal structures to foster collaboration between technical and creative teams (Kaszynska and Crossick, 2016). Engineering professionals often struggle to find clear roles in creative industries and feel undervalued in environments that focus on artistic creation. Lack of integration of technical professionals in creative processes can lead to alienation or frustration.

Whether CCIs adequately accommodate engineers is a key concern in integration. Engineers want to apply their skills in creative fields, but they need to see that these industries welcome their ideas and can adjust to their methods. Evidence shows that while some creative industries have advanced in integrating technical knowledge, particularly in digital media and interactive design, many still operate in isolation, with technical and creative teams working independently instead of collaboratively (Banks and Hesmondhalgh, 2009).

Insufficient integration of technical and creative professionals in CCIs can lead to underutilization of engineers, who may be seen only as problem-solvers or "technicians" instead of equal partners in the creative process (Eikhof and Warhurst, 2013). This hierarchy can hinder integration, as engineers may feel undervalued or restricted to certain tasks, limiting their involvement in the creative aspects of projects. Literature highlights the importance of creating collaborative environments where engineers can share their technical skills and creative ideas with artists, designers, and other creatives to produce innovative work (Kaszynska and Crossick, 2016).

Integration complexities go beyond just engineers. CCIs should adjust to enhance inclusivity for technical professionals by creating frameworks that promote collaboration and value engineers' unique expertise. Dismantling departmental barriers and fostering equal collaboration between technical and creative experts is essential. Research shows that the future of CCIs depends on this integration, as creativity and technology converge in areas like digital media, gaming, and virtual reality (Bakhshi et al., 2013).

The testable hypotheses from the "Integration" pillar of our framework are:

Engineers worry about their lack of artistic skills and how it affects their ability to effectively communicate technical solutions to those unfamiliar with the CCIs. This hypothesis explores whether engineers feel unprepared to link their technical expertise with the creative and subjective skills highlighted in the CCIs.

Engineering professionals worry about a cultural mismatch between their education, experience, and work style, and the operational methods of future colleagues in the CCIs. This hypothesis aims to explore whether engineers see a cultural gap between their structured training and the flexible mindset of creative industries. This gap may deter engineers from careers in CCIs.

We present the data used to investigate these hypotheses and the methodology for data collection. We present and analyze the results.

3 Methods and data

This study analyzes survey data from students at Satbayev University, a top educational institution in Kazakhstan ranked 405th globally in the QS World University Rankings 2024. Satbayev University ranks higher than 58 UK universities and 144 US universities in the Top Universities 2024 ranking, which is highly substantial, given the most UK and US universities are not even adept enough to make the QS rankings. These numbers only refer to the US and UK universities that Satbayev University surpasses among those that actually appear in the rankings. The institution is known for its engineering and STEM expertise, making it a great place to understand factors influencing engineers' career choices.

A survey was distributed voluntarily to all 9,500 students at Satbayev University. We received 104 responses in 1 week. We deliberately did not re-prompt responses in order to avoid low-quality answers. Although small compared to the total student population, 104 responses are sufficient for descriptive analysis. Smaller, targeted samples can provide deep insights, especially for studying complex, non-representative issues (Marshall et al., 2013).

The survey was designed to be brief, requiring only 5 min of students' time to encourage participation. The survey's brevity follows established survey design principles, promoting higher response rates and data quality (Dillman and Smyth, 2007). The language of the survey was Russian, which is the *lingua franca* of Satbayev University, even though most students are fluent in English as well. However, we did not wish to introduce linguistic barriers to interacting with the survey. Questions were carefully crafted to avoid leading participants. For instance, the poll aimed to find out if students believed the university had a role in supporting non-traditional career paths for engineers, rather than directly asking about increasing guidance efforts in CCIs. Likert scales and binary responses were used to simplify the analysis and minimize reference bias. This framework allowed students to share their views on CCI careers, their knowledge of these careers, and their assessment of risks like salary and job stability. Literature shows these techniques help reduce biases and improve feedback clarity (Artino et al., 2014). For full transparency, we have included a complete list of the survey's questions, translated to English, in the Annex to this paper.

This study's setting is Kazakhstan, but its results apply to Western Europe and North America. Kazakhstan's structural and curricular issues reflect broader global trends. Kazakhstan's engineering curricula, like those in Western universities, tend to be rigid, offering limited chances for interdisciplinary exploration (Coonan and Pratt-Adams, 2018). STEM students worldwide, including in the US, lack exposure to creative industries in their studies, limiting their awareness of unconventional career paths (Henriksen et al., 2015).

The labor market in Kazakhstan is increasingly aligning with industrialized economies. Kazakhstan prioritizes expanding its CCIs through national development initiatives addressing challenges seen in Europe and North America, according to UNESCO. Challenges include freelance work and project-based employment, leading to financial instability for professionals.

The respondents' composition analysis provides valuable insights, as shown in Tables 1, 2.

The majority of our respondents are students in data and business engineering (61.6% of them), computer engineering (7.7%), and mechanical engineering (20.2%). This is beneficial for our study, as these specialties are indeed most prone to leading to careers in the CCIs. The remaining 10.5% of our respondents is made up of students of chemical, electrical and civil engineering. The majority of respondents were Masters' degree students in full-time education (77.9%) nearing entry into the workforce, offering a glimpse into the concerns of soon-to-be freshly minted engineers. 11.5% of our respondents were second-year undergraduates. The remaining 10.6% of our sample consisted of first-, third- and fourth-year undergraduates.

In contrast to this, the student population at Satbayev University is composed in the following way. 8% of all students are postgraduates, 26% of them are second year undergrad students and 66% of them are first-, third- or fourth-year undergraduates. 15% of them are enrolled in data and business engineering, 20% in computer engineering and 15% in mechanical engineering. The remaining 50% of the student pool includes other specializations, such as chemical, electrical and civil engineering.

Our sample is therefore not representative of the overall student body at the university, but this was never an aim for our study. Our approach is about concentrating on the specific subset of students most relevant to the research question. Including a larger proportion of students in disciplines more likely to feed into CCIs allows us to obtain data that reflects the nuances and motivations behind choosing such career paths. The very fact that these students are near-graduates and have reached a level of specialization in their fields means they can offer more mature insights than a randomly selected group from all years and disciplines might.

The utility of this approach also becomes clearer when considering the fields that are respondents pursue. While some chemical, civil, or electrical engineering students responded to our questionnaire, they are by no means the majority and they are less likely to transition directly into CCIs. The majority of respondents are in data, business, computer, and mechanical engineering—fields with some connections to the rapidly evolving digital and creative sectors. Their oversampling through voluntary response bias puts the study in a stronger position to answer questions directly related to CCIs. It also allows for

TABLE 1 Distribution by engineering specialization.

Specialization	Sample (%)	University population (%)
Data and business engineering	61.6	15.29
Computer engineering	7.7	20.07
Mechanical engineering	20.2	14.67
Other engineering	10.5	49.99

TABLE 2 Distribution by year of study (educational level).

Educational level	Sample (%)	University population (%)
Masters' degree students	77.9	7.9
Second-year undergraduates	11.5	26.5
First, third, fourth-year undergraduates	10.6	65.6

strengthening our study's applicability beyond a single institution by providing a more targeted view of future workforce trends in CCIs, making it a more valuable contribution to understanding career dynamics in technical fields transitioning into creative industries.

It is important to acknowledge that qualitative insights—such as in-depth interviews or focus groups—could further enrich this research. However, for full transparency, the authors are committed to publishing interview outcomes without anonymity, provided participants give written consent. Considering that the survey respondents were about to enter the labor market at the time of this research, we did not wish to jeopardize this process by exposing students from our own institution to potentially unwanted prejudice from future employers.

4 Findings

4.1 Interest

This section presents our survey findings related to the Interest domain of our framework. The analysis looks at engineering students' awareness of job opportunities in the CCIs and their interest in careers in these industries. We examine the link between participation in artistic extracurricular activities in high school and university and the knowledge and interest in the CCIs.

We used participation in artistic extracurricular activities in high school to gage intrinsic interest. This is shown in Table 3.

44.2% of our respondents participated in artistic extracurricular activities in high school, including performing or visual arts clubs. These findings indicate that many engineering students have a tendency toward creative activities, suggesting an inherent interest in the arts among them. This interest, however, does not seem to lead to ongoing engagement with the arts in university. Participation in artistic extracurricular activities dropped significantly in university compared to high school, with only 22.3% of respondents involved. These findings show that enthusiasm for creative activities decreases over time, likely due to the intensity and organization of STEM education programs. The Institutions dimension of our framework is relevant here, as university curricula often lack support for interdisciplinary or creative involvement, leading to reduced arts participation as engineering students progress.

Our findings on awareness of and interest in CCI careers are summarized in Table 4.

32.7% of participants have a moderate or high awareness of job prospects in the CCIs. Meanwhile, 38.4% of participants reported being unaware or lacking knowledge about these opportunities. Engineering students on balance therefore have some understanding of career options in the CCIs, but many still lack awareness. The percentage of students interested in careers in CCIs is notably low at 27%. This gap between awareness and interest shows that simply being aware is not enough to spark interest in creative careers. 39.4% of participants showed only limited or no interest at all for careers in the CCIs.

Survey responses show a strong link between participation in artistic extracurriculars and knowledge and enthusiasm for CCIs. The findings are summarized in Table 5.

Students involved in artistic extracurricular activities in high school are 0.4 Likert-scale points more likely to know about career paths in the Cultural and Creative Industries (CCI). Students with an arts background show a slightly higher awareness of career prospects in creative industries, as indicated by the 10% statistical significance of this result.

The impact of participating in artistic extracurricular activities at university is much greater. Students engaged in artistic activities at university are 0.86 Likert scale points more likely to know about career paths in the CCIs. This finding is significant, with a 1% confidence level. These findings show that ongoing engagement in creative activities during university greatly influences students' awareness of career options in the Creative and Creative Industries (CCIs). Students involved in artistic extracurricular activities at any level are 0.5 Likert scale points more likely to show interest in careers in the CCIs. This result is significant at the 10% level. There is a clear link between ongoing creative engagement and awareness of, as well as interest in, careers in the CCIs.

The findings align with the Interest aspect of our framework, showing that while engineering students have a natural interest in the arts, it often fades during their university years. The drop in participation in artistic extracurriculars from high school to university suggests that factors like engineering program structures and lack of interdisciplinary options may play a role in this decline. The gap between awareness of CCI career paths and actual interest in these professions highlights a major issue: many students, despite knowing about suitable roles in creative industries, do not find them appealing. This may relate to concerns about financial stability or fit with the company culture, which will be explored in the following sections.

4.2 Educational path dependencies

The survey reveals how educational factors affect engineering students' openness to creative fields and their perceptions of the university's role in shaping career paths in the creative and cultural industries.

The results regarding the willingness of students to enroll in artistic and cultural elective courses is summarized in Table 6.

36.6% of participants indicated they would enroll in more arts and culture elective courses if offered. Only 14.4% showed no interest in doing so. Nearly half of the participants (49%) show

TABLE 3 Participation in artistic extracurriculars.

Participation in artistic activities	In high school (%)	At university (%)
Participated	44.2	22.3
Did not participate	55.8	77.7

TABLE 4 Awareness of and interest in CCI careers.

Level of awareness and interest	Percentage (%)—awareness of CCI careers	Percentage (%)—interest in CCI careers
Moderate to high	32.7	27
Unaware or uninterested	38.4	39.4
Neutral/unsure	28.9	33.6

TABLE 5 The link between participation in artistic extracurriculars and interest in or awareness of careers in the CCIs.

Participation level in artistic extracurriculars	Increase in Likert scale points of interest or awareness in cci careers brought about by participation in artistic extracurriculars	Statistical significance level
Knowledge of CCIs career paths		
Participated in high school	0.4	10% ($p \leq 0.10$)
Participated in university	0.86	1% ($p \leq 0.01$)
Interest in CCIs careers		
Participated at any level	0.5	10% ($p \leq 0.10$)

neutrality on this issue. The opposition to arts-related electives is lower than the percentage of those uninterested or uninformed about CCI careers. The lack of enthusiasm for creative professions therefore does not necessarily stem from a resistance to creative education itself.

Openness to creative learning and career interest are independent concepts. Research shows that the willingness to adopt new learning methods or interdisciplinary education does not always align with a particular professional interest. It can help develop a broader range of skills and perspectives (Henriksen et al., 2015). Over one-third of our respondents show interest in creative disciplines, even without immediate professional goals in creative industries. This suggests that adding interdisciplinary electives to the curriculum could spark greater future interest in these fields.

Additionally, 36.6% of students believe that multidisciplinary courses are essential for an engineer's career, while only 14.4% disagree, as Table 7 shows. The response breakdowns are identical to those shown in Table 6, with most of the responses indeed mapping into one another regarding the willingness to enroll in artistic and cultural courses and the importance attributed to multidisciplinary curricula.

While direct interest in a career in the creative industries may be low, the data shows a strong willingness to integrate creative skills into technical education. Research shows that exposure to various disciplines enhances innovation and creative problem-solving in STEM fields (Kaszynska and Crossick, 2016). Including such courses could benefit individual professional growth and promote interdisciplinary thinking among engineers.

A key institutional aspect is how universities are seen to promote job opportunities in the CCIs for engineers. The results of our research on this aspect are summarized in Table 8.

Only 14.4% of our respondents believe that the university has no role in this, while 33.7% of them assert that it does. 51.9% of respondents are neutral on this question. This result highlights the importance of institutions in shaping career awareness and paths, particularly in unconventional industries like the CCIs.

Universities indeed play a vital role in broadening students' career perspectives through counseling and job fairs (Tomlinson, 2012). Specialized career guidance programs in institutions could effectively address the disparity in awareness and interest in CCIs.

TABLE 6 Responses to the question "How likely are you to choose elective courses, if offered, that combine engineering and the arts (e.g., creative programming or digital design)?"

Response	Percentage (%)
Would enroll	36.6
Neutral	49
Would not enroll	14.4

TABLE 7 Responses to the question "In your opinion, how important are interdisciplinary courses for the long-term career of engineers?"

Response	Percentage (%)
Agree	36.6
Neutral	49
Disagree	14.4

TABLE 8 Responses to the question "How important is it for universities to offer more opportunities for engineers to engage with the arts and creative industries?"

Response	Percentage (%)
The university has a role	33.7
Neutral	51.9
The university does not have a role	14.4

These preliminary findings regarding institutions present an opportunity for universities to integrate more arts and interdisciplinary electives into STEM curricula. These modifications could help students gain a wider range of skills, preparing them for a diverse job market and possibly increasing their interest in careers that blend creativity and technical skills (Adams et al., 2011). A longitudinal study is needed to assess the long-term impact of increased arts education on engineers' career choices.

4.3 Economic factors

The economic dimension of our framework looks at how salary expectations and job security affect engineers' career choices, particularly in creative and cultural industries (CCIs). Survey results show that salary and job security are crucial for aspiring engineers. These findings are summarized in Table 9.

58% of our respondents view salaries as "extremely important" in making career choices and 17% of them feel that they are very important. Only 7.7% of the respondents feel that salaries are unimportant factors when choosing careers. The remaining respondents are neutral about this issue. Similar patterns are observed regarding job security. 50% of our respondents feel that this is crucial in their career choices and 28.8% of them deem it "very important." Only 12.5% of our respondents attach no importance to job security, with the remainder of our respondents being neutral about the issue. These findings align with studies highlighting the importance of financial gains in shaping career priorities among STEM graduates (Sullivan et al., 2018). Research shows that engineers, due to the high cost of their degrees, prioritize secure and well-paying jobs to ensure a good return on their investment (Carnevale et al., 2011). Both

TABLE 9 Summary of the importance attributed to salaries and job security.

Importance attributed to...	... salaries percentage of answers (%)	... job security percentage of answers (%)
Extremely important	58	50
Very important	17	28.8
No strong opinion either way	17.3	8.7
Not important	7.7	12.5

remuneration and employment stability are expected to significantly influence their decision-making (Table 10).

In spite of our findings and the background from previous literature, only 25.9% of participants worry about meeting their salary expectations in the CCIs, while 31.7% are confident they can earn enough with their skills. While 28.8% of individuals worry about job security in the CCIs, a similarly-sized 27% of our respondents do not express any concerns about instability in the CCIs, with the remainder of our respondents being neutral about the issue.

These findings do not necessarily align with previous research. Eikhof and Haunschild (2007) note that the unstable employment in creative industries, characterized by freelance work, temporary projects, and uncertain income, often discourages qualified individuals from entering this field. Throsby (2001) argues that the financial risks associated with creative professions are significant enough to deter STEM graduates who have spent years developing valuable technical skills. Our results contradict these viewpoints, showing that engineering students do not see salary and job security risks in the CCIs as overly burdensome. This divergence may be due to the increasing demand for technical skills in creative fields. Bakhshi et al. (2013) argue that digitalization in contemporary creative industries has created new opportunities for engineers in areas such as digital media, data analytics, and immersive technologies. These fields offer engineers better pay and more stable job opportunities than traditional creative roles. This may explain why many participants feel confident about their financial opportunities in the CCIs, despite the usual narrative of financial instability in these sectors.

4.4 Integration

The Integration dimension of our framework evaluates aspiring engineers' views on their ability to fit into the CCIs. This includes their ability to communicate technical solutions to non-technical staff, an essential skill for interdisciplinary work in the CCIs, along with their desire to collaborate with industry colleagues or take roles that match their technical education.

Our study found that 33.7% of respondents felt confident in sharing their technical expertise with non-technical audiences. On the other hand, 19.2% of respondents had no confidence in doing this, while 47.1% were neutral on the issue. Table 11 summarizes these findings.

This outcome indicates that while many engineers are confident in bridging technical and non-technical domains, a significant number still feel uncertain or unprepared in this area. This barrier can be overcome, even though the lack of interdisciplinary communication has been documented to hinder engineers' career prospects in the creative industries (Kaszynska and Crossick, 2016). Specific training and institutional support could help alleviate this issue.

TABLE 10 Concerns regarding meeting salary expectations and obtaining sufficient job security if/when pursuing a career in the CCIs as an engineer.

Concerns regarding...	... meeting salary expectations with a potential career in the CCIs percentage of answers (%)	... job security with a potential career in the CCIs percentage of answers (%)
Expressing worries about it	25.9	28.8
Neutral on the issue	42.4	44.2
Not worried about it (at all)	31.7	27

TABLE 11 Percentage breakdown of answers to the question "How confident do you feel applying your technical skills in non-technical fields (for example, explaining complex concepts to people specializing in the arts and humanities, or advising on the best way to achieve a certain goal based on your technical expertise)?"

Response	Percentage (%)
I feel confident	33.7
I have no feelings either way	47.1
I do not feel confident	19.2

Another key aspect of integration is engineers' desire for roles that match their technical education and their willingness to work with industry colleagues. The results regarding this aspect are summarized in Table 12.

77.8% of participants prefer jobs that match their technical skills. Furthermore, 74% of respondents show strong interest in collaborating with their engineering peers. The figures indicate that most aspiring engineers have an innate desire to remain within their training and professional networks.

Furthermore, our survey indicates that 29% of participants are concerned about their artistic skills meeting the CCIs' requirements. 31.7% of our respondents have no such concerns with the remainder of them being neutral about the issue. Additionally, 24% of participants are concerned about potential cultural incompatibility with other CCI employees, while 31.7% are confident they will not face such a conflict. The remainder of our respondents are neutral on this issue. These findings are summarized in Table 13.

This aspect of our findings aligns with literature highlighting a cultural gap between engineers and creative professionals (Hesmondhalgh and Baker, 2011). Our study indicates that the cultural mismatch is not as major a barrier for engineers as stated in the literature. Instead, the main obstacle to the proper integration of engineers in the CCIs may be a perceived lack of suitable skills and the desire to remain among engineering peers. Engineers tend to prefer jobs that make the most of their skills. Engineers moving to new industries like the CCIs may feel anxious due to the lack of direct practical use for their technical skills (Jones et al., 2017). It is essential to address this fear for Higher Education Institutions. To overcome this challenge, institutional support and active participation from CCIs are essential to show that these industries value and can effectively use engineering expertise.

TABLE 12 Percentage breakdown of answers to the question "How important is the relevance of your technical skills to the industry you work in for your career choice?" and "How important is it for you to collaborate with your professional peers at your future workplace?

Importance	Relevance of technical skills to the industry percentage of responses (%)	Collaborating with professional peers percentage of responses (%)
Important	77.8	74
I have no feelings either way	16.8	18.4
Not important	5.4	7.6

TABLE 13 Expressed concerns about cultural incompatibility with CCI employees and a lack of artistic skills.

Concerns regarding...	... a lack of artistic skills necessary for the CCIs percentage of answers (%)	... about a cultural mismatch with the CCIs percentage of answers (%)
Expressing worries about it	29	24
Neutral on the issue	39.3	44.3
Not worried about it (at all)	31.7	31.7

5 Implications and discussion

The analysis of findings across our framework reveals complex and unexpected ways prospective engineers evaluate their fit with the creative and cultural industries (CCIs). The results show that the challenges for engineers entering the CCIs go beyond concerns about salary or job security. They are marked by complex aspects of confidence, cultural fit, and institutional influence. The objective of our research is not to rank barriers against one another. Therefore, these findings do not imply that economic considerations do not matter for engineers when deciding to pursue careers in the CCIs or not. However, they do highlight that perceived skill gaps and institutional deficiencies are barriers that may keep engineers from the CCIs.

Our findings suggest that the interaction between Interest and Integration is crucial. Engineers' disinterest in CCIs is not due to a fundamental dislike of creativity or the arts. There is strong enthusiasm for creative fields, especially in early education, shown by participation in extracurricular activities. However, popularity wanes over time, suggesting that rigid engineering education frameworks may be steering students away from interdisciplinary pursuits. Institutions directly impact students' paths by either enabling or restricting their access to creative fields. A more inclusive agenda with arts electives or interdisciplinary projects can help students view their technical skills in a new light and apply them creatively.

The economic dimension adds depth to our analysis. While literature suggests engineers react strongly to financial instability, our research shows that concerns about salary and job security in the CCIs are not necessarily prohibitively large.

Engineering students report feeling unsure about their ability to effectively communicate with non-technical staff or adapt their technical skills to the more chaotic, multidisciplinary environments typical in CCIs. There is a notable gap between how students view their technical education and its relevance to creative fields. Engineers focus on accuracy and clear roles, but CCIs require flexibility and teamwork across disciplines. Students seem concerned about how their skills will be used and valued in creative roles.

These findings suggest several practical measures that could improve mutual understanding and collaboration between engineers and the CCIs. One of them is the need for restructuring engineering curricula. Universities must expand interdisciplinary options, allowing engineering students to take elective courses in the arts and humanities. This approach would sustain students' enthusiasm for creative fields and improve their communication and collaboration skills, which engineers find lacking, as our survey suggestions. Some Western institutions have tried to combine digital media and engineering in joint courses (Bakhshi et al., 2013), but overall adoption has been limited. These findings show that educational institutions can significantly enhance interdisciplinary skills.

Career counseling and job fairs could also promote non-traditional roles in the CCIs where engineering skills are increasingly important. Research shows that when schools promote diverse career options, especially in creative fields, students are more likely to explore these opportunities (Henriksen et al., 2015). Many universities still focus heavily on traditional industries like manufacturing and technology, overlooking creative professions.

Employers in the CCIs should also rethink their recruitment and integration strategies for engineers. Creative industries should recognize engineers' skills and create clear pathways for them to see how their technical expertise aids creative processes. This task involves resolving cultural disparity and providing essential training to help engineers in contributing effectively. Current methods connecting technical and creative fields, like digital upskilling initiatives (Kaszynska and Crossick, 2016), show promise but require expansion and customization for specific engineering skills.

Our findings impact R&D in the CCIs. Technical innovation, including digital media and artificial intelligence, is increasingly vital in the creative industries, requiring both creative and technical skills. Engineers are vital to this transformation, and industries must actively seek and include these experts. Our research shows that perceived skill disparities could halt research and development in the Creative Industries if innovative companies cannot attract technical professionals.

Collaboration between engineers and creatives is essential and offers a great opportunity for innovation. Research shows that integrating diverse viewpoints leads to more creative outcomes (Bakhshi et al., 2013). This is clear in creative sectors, where technology enables new forms of artistic expression. Involving engineers in R&D within the CCIs can boost the development of new technologies, such as advanced digital tools for media production, data-driven creative processes, and immersive virtual reality environments.

We acknowledge that our study has limitations. The sample size is limited and originates only from one university. Further investigation should include more institutions to improve the generalizability of the findings. Our study offers preliminary insights into the taxonomy of obstacles keeping engineers from the CCIs, but it may not fully capture the views of students uninterested in creative careers. Longitudinal studies would greatly help assess the lasting impacts of interdisciplinary education on professional development. Monitoring students' career paths over time would provide key insights into how curriculum reforms address the obstacles tentatively identified in this study.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

AT: Funding acquisition, Methodology, Validation, Writing – original draft, Writing – review & editing. BA: Investigation, Methodology, Resources, Writing – original draft. MF: Conceptualization, Formal analysis, Software, Supervision, Writing – original draft, Writing – review & editing. SR: Data curation, Investigation, Resources, Writing – review & editing. ZKo: Investigation, Project administration, Validation, Writing – original draft. ZKi: Resources, Software, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2024.1507039/full#supplementary-material

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