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More than just location: how engineering undergraduate students choose their schools and programs

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Introduction: Engineering higher education faces difficulties in attracting and enrolling motivated students in engineering programs. These challenges call for a deeper insight into the factors that influence student choice when selecting an institution and its engineering programs. Understanding these factors enables institutions to comprehend why students prefer one institution over others and leads to strategies that can enhance the overall student experience, which could ultimately increase enrollment and retention.

Methods: The current study conducted a mixed inductive and deductive content analysis of open-ended responses from a multi-institutional survey administered to undergraduate engineering students (n = 473) across nine states in the Northeastern and Midwestern United States. Students responded with their main reasons for choosing their current schools for their engineering education.

Results: The results yielded a total of 25 factors reflecting a robust number of reasons why undergraduate engineering students chose a university/program. The most frequently mentioned factors included location, program standing, career development, athletic, institutional standing, majors, and cost. Meanwhile, factors such as religion, safety, study length, research, influences from others, and expected income were the least frequently mentioned. Results also showed that racial minority students were more likely to have institutional curriculum and tuition assistance programs, but less likely to have school size, location, and athletic programs as reasons why they chose their university/program. The results showed a similar pattern for female students. The results highlight the importance of accentuating and differentiating location in marketing strategies in engineering programs.

Discussion: Our study highlights several equally influential factors, including Program standing and Career development. These call for a greater effort to establish a distinct brand image for each engineering program to promote themselves instead of leaning heavily on broader reputation and standing as a school. Institutions should tailor their promotional strategy to focus on showcasing the characteristics of individual engineering disciplines that align with a prospective student's interests, rather than providing a general institutional standing overview. Faculty could showcase real-world projects and incorporate undergraduate research experiences into coursework, matching students' skill levels and reflecting the practice of "meeting where students are," ultimately shaping students' educational paths and career trajectories.

KEYWORDS

undergraduate engineering education, decision-making factors, marketing strategy, engineering student retention, engineering student success

1 Introduction

With the rapid pace of technological development and the increasing integration of technology into various aspects of life, the job market shows a strong demand for engineers to design, develop, and maintain complex systems (Fleming et al., 2024). According to the U.S. Bureau of Labor Statistics data, employment growth in engineering fields is expected to outpace the average growth for all other occupations, with an anticipated increase of about 13% from 2023 to 2031 (U.S. Bureau of Labor Statistics, 2025). However, on the other hand, higher education institutions face difficulties attracting and enrolling motivated students in engineering programs due to various reasons, such as perceptions of the difficulties of coursework or a lack of diversity in the industry (Desing et al., 2024; Gille et al., 2022). As a result, engineering higher education has encountered increasingly complex challenges in recent years, including growing competition for reputation and funding, rising operational costs, and declining enrollments (Abbas et al., 2021; Kuehn and Salzman, 2018). These challenges call for a deeper insight into the factors that impact student choice when selecting an institution and its undergraduate engineering programs (Gille et al., 2022). A deeper understanding of these factors not only informs institutional recruitment and marketing strategies but also enables institutions to enhance program quality, align educational outcomes with industry demands, and foster a more sustainable pipeline of future engineers.

Furthermore, understanding these factors allows the institution to comprehend why students prefer one institution/Program over others. In a competitive higher education landscape, the escalating costs of tuition fees result in greater consumerist behavior by students and parents in their decision-making process (Gordon-Isasi et al., 2021). As a result, a higher education degree has become a positional good, where students, parents, and employers perceive colleges and degrees as providing greater social status and better lifetime opportunities (Smolentseva, 2023). Thus, knowing why students choose certain universities/programs over others is central to developing institutional positioning in an increasingly competitive higher education environment (Maringe, 2009). Additionally, the insights gained can and should inform the development of effective marketing strategies for the institution (Retamosa et al., 2024). Moreover, understanding student choices and perceptions could provide insights into their expectations and highlight strategies that could enhance the overall student experience, which could offer institutions evidence-based practices to pursue necessary changes to eventually increase enrollment and retention.

Previous studies of undergraduate engineering education in the U.S. mainly focus on identifying factors that could influence students' choice of engineering majors without considering factors that influence their choice of institutions/programs (Main et al., 2022). However, students' choice of institutions or programs is not only economically rational but also influenced by numerous situational and contextual factors, such as academic achievement and school experience (Hemsley-Brown and Oplatka, 2015; Menon et al., 2007). In addition, researchers consistently aim to uncover whether demographic variations exist among students opting for different universities (Briggs, 2006). To the best of our knowledge, there has been limited work to thoroughly map the factors that sway institutional choice and to understand the decision-making process in engineering education. Therefore, to fill this gap in the existing literature, the current study seeks to (1) explore the factors that influence students who are interested in engineering to choose an institution; (2) investigate the prevalence of identified factors; (3) examine whether and how demographic factors correlate with such factors that sway students' choices.

2 Literature review

Despite the robust debate over whether educational institutions should get involved in marketing, there is no denying that higher education has been transforming from a centrally funded, non-marketized entity to a highly marketized and competitive environment (Hall, 2024). Although some scholars think that students should not be considered customers, this argument is only valid when the government finances all higher education, which currently is not the case in the United States, the United Kingdom, and many other European countries (Agasisti and Catalano, 2006; Raza et al., 2021). A student's choice to pursue higher education in these countries often results from evaluating the costs and benefits, much like how a consumer chooses a product or service. Students need to navigate decision-making processes to select the best options, which is a multi-faceted process involving a wide range of factors that affect the eventual decision (Maringe, 2006). Therefore, as prospective students have a wider variety of institutions/programs to choose from, the need for institutions to differentiate themselves from their competition is self-evident. This highlights the importance of the marketing approach in not only understanding students' needs but also in program design to attract more students during recruitment (Ivy, 2008). In other words, it is paramount for institutions to understand these influencing factors to tailor their design and marketing in order to compete for funding and more students (Drummond, 2004; El Nemar et al., 2020).

2.1 Marketing mix for higher education

The current study utilizes this 7Ps marketing mix model (Kotler and Fox, 1995) as a guiding framework to categorize and understand the multifaceted and often complicated factors that could influence prospective engineering students' choices. The marketing mix refers to a set of manageable marketing tools that an institute blends to deliver services to its various target markets (Ivy, 2008). In the context of higher education, this could encompass all the actions the institutions can take to shape the demand for their services among potential and current students. Tangible products have traditionally used a 4Ps model as a marketing guide (Lahtinen et al., 2020). On the other hand, higher education marketing often uses a 7Ps model initially developed by Kotler and Fox (1995): Program, Price, Place, Promotion, People, Physical evidence, and Processes.

The 7Ps model offers an overarching and comprehensive look into what factors might matter to any student on a college search journey, no matter what major they are interested in. However, students interested in engineering often exhibit distinct academic and cultural traits shaping their institutional preferences. For example, previous research studies show that potential students are attracted to engineering programs marketed as industry-collaborative, technological innovation-driven, and hands-on learning environments (Litzinger et al., 2011; Main et al., 2022; Wang et al., 2022). In engineering education, these could roughly translate to, but are not limited to, accreditation and curriculum structure, internship programs, industry connections, and employment prospects. In addition to the 7P model, previous research used other theoretical models, such as Expectancy-Value Theory (Eccles, 1983), Theory of Planned Behavior (Ajzen, 1991), or Self-Determination Theory (Deci and Ryan, 2012) to explain student behaviors and the decision-making process through the psychosocial lens. However, we find the 7P model to be the most comprehensive and relevant theoretical model to explore the intervenable factors in higher education that determine students' decisions and also serve as the guiding framework to direct and manage higher education resources, so we find the 7P model fits the best with the purposes of the current study. As previously stated, there has been limited work to thoroughly map the factors that sway institutional choice and understand the decision-making process in engineering education. Thus, the following sections review each of the 7Ps elements and ask research questions regarding the contextualization of each element within engineering education.

2.1.1 Program

The Program is the marketing mix model's first and most fundamental element as it shapes the institution's identity (Kotler and Fox, 1995). The Program represents the educational products provided for students and the students themselves as products delivered to the labor market (Mahajan and Golahit, 2019). To satisfy the labor market's needs, institutions must keep their products current to build a strong connection with the latest industry advances and company demands (Ryńca and Ziaeian, 2021). The educational products encompass all the programs available within the university, such as degree programs, classes, research projects, career development within the industry, and any other extracurricular activities (Gallagher and Savage, 2023). Needless to say, one would reasonably assume this element would significantly influence how students choose a school/program, but the nuanced contextualization of engineering education among students remains largely unexamined. Thus, this leads us to ask the following research questions:

> *RQ1a:* What are the engineering education-specific Program factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ1b:* How prevalent are these engineering education-specific Program factors in students' decisions?

2.1.2 Price

The second element of the marketing mix is Price, which is defined as the amount of money students and parents pay the university for services in higher education (Hayes, 2013). Price typically includes tuition fees, scholarships, and any additional costs, such as living costs (Amir et al., 2016). Some scholars further argued that the price also includes non-financial costs such as time, inconveniences, and distance between the institution and the student's residence (Henderson, 2023). Institutions could use a price strategy to attract students by clearly articulating the value proposition, addressing affordability, and emphasizing financial aid and transparent cost communication (Lim et al., 2020). It has a significant impact on the institutions' marketing strategy and branding efforts. Many students are concerned about the financial implications of attending institutions, and those concerns could sway their choices in which school/program to choose. However, given the relatively unknown nature of how the price element affects engineering education choices, we ask the following research questions:

> *RQ2a:* What are the engineering education-specific Price factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ2b:* How prevalent are these engineering education-specific Price factors in students' decisions?

2.1.3 Place

The Place element of the marketing mix refers to the location of the institution and the accessibility for students (Ivy, 2008). It is related to the physio-geographical delivery of education services, which is concerned with the location and distance of the institution from home and the characteristics of the area in which it is situated (Kotler and Fox, 1995). This element is commonly measured in terms of convenience, suitability, and approachability of the place of education service delivery (Gruber et al., 2010; Mahmoud et al., 2024). A good locality surrounded by transport connectivity, entertainment facilities, medical facilities, and cultured climates could attract prospective students. In addition, the place is also linked to the accessibility and connectivity to the in-campus classrooms, laboratories, amenities, and dormitory (Maringe, 2006). In addition, the relationship between campus safety and institution selection has intensified in recent years. Previous research shows that if institutions fail to address safety concerns sufficiently, many potential families and students may look elsewhere even when the institution fits all other items on the bill (Billingham et al., 2024; Chekwa et al., 2013). To examine this element further, we ask the following research questions:

> *RQ3a:* What are the engineering education-specific Place factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ3b:* How prevalent are these engineering education-specific Place factors in students' decisions?

2.1.4 Promotion

The Promotion in the marketing mix refers to all the tools institutions can use, such as advertising and public relations, to provide the market with information about their offerings (Pucciarelli and Kaplan, 2016). Reputation is the sum of the impressions students receive from their communication and interactions with the institution, which is considered a psychological image of the institution (Mateus and Acosta, 2022). The psychological image contributes to the satisfaction of students who are the customers of educational products, which could significantly influence their decision-making process when selecting institutions (Tight, 2020). Many studies provided empirical evidence that the reputation/image of an institution significantly contributed to student satisfaction (Elsharnouby, 2015; Foroudi et al., 2019; Calma and Dickson-Deane, 2020). Furthermore, Ho and Hung (2009) argue that establishing a unique image in the eyes of competitors and consumers is advantageous for market positioning and targeting. From these perspectives, promotion strategies are important for institutions to develop and keep a good reputation among prospective students and employers in the labor market (Panggabean et al., 2024). To understand how promotion factors, such as institutional and program reputation, affect engineering students' choices, we ask the following research questions:

> *RQ4a:* What are the engineering education-specific Promotion factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ4b:* How prevalent are these engineering education-specific Promotion factors in students' decisions?

2.1.5 People

The People in the marketing mix represent all the institution personnel interacting with prospective students. The educational service is strongly connected with the people involved in delivering it, including the teaching and administrative staff (Anane-Donkor and Dei, 2021). Students' views on the reputations of teaching staff can significantly affect their decision-making in selecting institutions (Woodall et al., 2014). For example, students may choose an institution based on the faculty's research projects and their expertise in specific fields (Lewicka, 2022). Some students may choose an institution solely based on how they feel about the interactions with faculty during a campus visit (Swanson et al., 2021). In addition, the administrative staff also affects how students perceive the quality of the service. They are directly involved in the enrollment process, often leading to the first impression of the university. For example, how a phone inquiry is handled could substantially influence whether a prospective student keeps a university as an option (Enache, 2011; Weerasinghe and Fernando, 2017). This leads us to ask the following research questions:

> *RQ5a:* What are the engineering education-specific People factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ5b:* How prevalent are these engineering education-specific People factors in students' decisions?

2.1.6 Physical evidence

Physical evidence highlights the tangible aspects of the environment that support educational service delivery (Hanaysha et al., 2021). Students evaluate a variety of tangible elements, ranging from the teaching materials to the appearance of the buildings at the institution. Physical elements such as buildings, infrastructures, and amenities serve as immediate clues for prospective students regarding the institution's identity and culture (Mughan et al., 2022). Amenities often offer a visual and tangible signal of institutional quality and prestige to students (McClure, 2019). The availability and quality of facilities (e.g., laboratory) could be a vital factor influencing students' enrollment choices, considering that facilities provide essential resources for teaching, learning, research, and extracurricular activities (Muhammad et al., 2014). Many universities adopt a distinctive visual identity for their physical infrastructure and amenities to enhance their reputation and reinforce the image of university culture (Jain et al., 2013; Teeroovengadum et al., 2016). For example, many institutions in the United States and Europe are using their football fields and new religious facilities as a platform for promotion and revenue generation (Ceyhun, 2025; Mross and Riehman-Murphy, 2021). However, it remains unclear whether such factors would influence engineering students' choices, so this leads us to ask the following research questions:

> *RQ6a:* What are the engineering education-specific Physical evidence factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ6b:* How prevalent are these engineering education-specific Physical evidence factors in students' decisions?

2.1.7 Process

Lastly, the Process is referred to as the way an institution conducts its business. It relates to the entire administrative framework in which the institute delivers the education service, and the service is acquired by students (Kotler et al., 2002). Specifically, the educational processes are instrumental in fostering student engagement and experience within and outside the classroom through academic, non-academic, and support activities, such as collaborative research with faculty, service-learning, industrial internships, sports, and cultural activities (Hanaysha et al., 2023; Kuh, 2009). These processes ultimately influence institution performance and the participation of a diverse student body (Gunuc and Kuzu, 2015). In addition, enhancing the student experience involves streamlining administrative tasks and ensuring clear communication. For example, this applies to procedures concerning academic support services, including admissions, course enrollment, and academic guidance (Khanam and Joshi, 2025; Masika and Jones, 2016). This leads us to ask the following research questions:

> *RQ7a:* What are the engineering education-specific Process factors that influence prospective students' institutional and programmatic decisions?
>
> *RQ7b:* How prevalent are these engineering education-specific Process factors in students' decisions?

2.2 Associations between institutional choices and demographics

Choice is an iterative concept, which is a complex process involving a wide range of influences that bear upon a decision. Economic models of choice, like the 7Ps marketing mix model discussed earlier, are based on the assumption that students make rational choices based on precise calculations of the relative rates of return associated with participating in higher education. However, many studies argued that choice is never a completely rational action, emphasizing the importance of personality and subjective judgments in decision-making. (Hodkinson et al., 1997, p.34), for example, argue that "choice is a rational process that is constrained by a realistic perception of opportunities and shaped by individual personality." Hemsley-Brown and Foskett (1999) endorsed this view in their study, concluding that while pupils often give utilitarian reasons for making choices, these were usually filtered through layers of preconceptions emanating from influences in family background, culture, and the influence of others. Therefore, besides the university-related factors derived from the marketing mix model, demographic factors could also play an important role in students' choices of universities.

The topic of how various demographic factors impact students is commonly framed in the literature regarding gender, race, socioeconomic status, and whether individuals are first-generation college students. Numerous studies have examined differences in preferences and actual choices among students based on gender in higher education environments (Ayalon, 2003; Boring and Brown, 2024; Priulla et al., 2025; Reay et al., 2005). For example, on average, female students opt for less competitive academic pathways (Landaud et al., 2020). They often prioritize other elements of their college experience, balancing academic challenges and overall satisfaction with school life, even though they are academically driven (Wyness et al., 2023). Moreover, female students from low-income families in rural settings are more inclined to select less selective universities, irrespective of their academic skills and aspirations. They demonstrate a heightened awareness of factors like the size and location of the campus, along with personal perceptions such as feelings of comfort and safety on campus (Nora, 2004).

Racial minority students often consider whether to participate in environments where they might encounter discrimination or where their demographic group is largely represented. In the college admissions process, race appears to carry more weight than gender for minority applicants; for example, Asian American students show a strong inclination toward selective institutions, applying to top-tier institutions compared to other racial groups (Kim and Gasman, 2011). Underrepresented minority students may be more attuned to social opportunities that foster a sense of belonging and connection during their college selection process (Leighton and Speer, 2023). In addition, socioeconomic status (SES) plays a vital role in shaping decisions about school choice (Delaney and Devereux, 2020). Studies from various countries reveal that students from lower SES backgrounds are less inclined to enroll in prestigious undergraduate programs or universities known for their high-achieving student bodies and positive job market prospects (Leighton and Speer, 2023). These students may grapple with pursuing these schools/programs due to a lack of confidence in their academic abilities or financial challenges. Furthermore, first-generation college students often have limited knowledge of college costs and application processes and typically receive less rigorous academic training in high school (Warburton et al., 2001). This gap in knowledge and preparation can affect their decision-making when evaluating which universities suit their needs. While there is some research on the associations between demographic variables and the factors that influence students' choices, little is known about engineering education. Given the aforementioned unique context of engineering education, we ask the next research question:

> *RQ8:* What, if any, are the associations between relevant demographic variables and engineering-specific factors that influence students' choices (as asked in RQ1 to RQ7)?

3 Methods

To answer RQ1 to RQ7, we conducted a content analysis of open-ended responses from a multi-institutional survey with undergraduate engineering students in the Midwestern and Northeastern United States. The study recruited students from 14 colleges/universities varying in size and type. Out of the 14 schools with participants who had more than 10 responses to the survey, 7 (50%) were private schools. The student enrollment size (i.e., university size) ranged from 1,141 to 46,900 (M = 15,336, SD = 14,907). In addition to relevant demographic factors (e.g., age), the survey asked undergraduate students to openly respond with their main reasons for choosing their current schools for their engineering education. While the current study presents results from a large-scale project, no operational variables shown in the current study were utilized or published in any previous articles (Wang et al., 2022,2024). Participants received a $5 gift card or extra credit upon completion of the survey.

3.1 Procedures

Participants were undergraduate students enrolled in engineering programs at institutions located in the Midwestern and Northeastern United States. A snowball sampling method was employed, in which a recruitment email was sent to 921 full-time faculty and instructors across 18 higher education institutions. The email requested recipients to disseminate the survey link to their current students. A total of 473 students from 14 institutions completed the survey. Upon obtaining informed consent, the survey collected four relevant demographic variables, including age, gender, race/ethnicity, and first-generation college student status (defined as no immediate family member having earned a college degree). Then, the survey asked students to openly respond to the question, "In a couple of brief sentences, please tell us what the main reasons are that you chose this university for your engineering education?"

3.2 Participants

We recruited a total of 514 undergraduate engineering students from 14 different universities. We removed 41 cases with missing data on the open-ended question (i.e., blank responses). The final sample consisted of 473 undergraduate engineering students with ages ranging from 18 to 49 (M = 20.98, SD = 3.11), and most participants identified as male (n = 296, 63.9%). Most participants identified as White/Caucasian (n = 370, 78.2%); 28 (5.9%) identified as Black/African American; 37 (7.8%) identified as Asian; 20 (4.2%) identified as Latino; 5 participants (1.1%) identified as Middle Eastern; 13 (2.7%) participants identified as multiracial. Out of the 473 participants, 68 (14.7%) identified as first-generation students.

3.3 Analysis

The open-ended question generated robust responses from students. The responses from 473 students yielded a total of 9,358 words, with a range of single-word answers to extended paragraphs. To analyze the textual data and answer RQ1 to RQ7, we conducted a mixed inductive and deductive content analysis using seven elements from the 7Ps model (Kotler and Fox, 1995) as the guiding theoretical framework (Kyngäs, 2020). Given the comprehensive nature of the seven elements in the 7Ps model, we chose the deductive approach to better organize and categorize overarching themes of our robust findings, which include Program, Price, Place, Promotion, People, Physical evidence, and Processes. However, given the unique context of undergraduate engineering education, along with the limited previous literature on factors that influence engineering students' institutional choices, we use an inductive approach to let the unique factors emerge from the data itself. It is important to note that our sample was collected only from the Northeastern and Midwestern United States, so the results should be interpreted within the recruitment methods.

First, three members of the research team conducted an inductive thematic analysis (Naeem et al., 2023) by reading each response at least twice to develop a coding system that could be used to categorize the responses to the open-ended questions in the survey. The codes developed were an exhaustive reflection of the data and were mutually exclusive from each other, following conventional recommendations (Naeem et al., 2023). After operationally defining each coding category, authors first independently coded a randomly-selected 10% of all open-ended responses to test the validity and reliability of the codes. After achieving 100% inter-coder reliability on a sample of 10%, two coders independently coded each response based on these categories and also noted responses for divergent themes or unique findings. The unit of analysis was each individual student response, and each response was coded exhaustively for all codable factors presented (1 = presence, 0 = absence); one response could have multiple frames. For example, a surveyed student responded to the question: "*It was ABET accredited, close enough to home, and I could run here. I also liked the smaller class sizes*."

The coding was completed manually using Excel. Then, the inter-coder reliability for each code was calculated using SPSS 27, and inconsistently coded results were highlighted. In total, the initial coding yielded an overall acceptable level of intercoder reliability (all $\kappa > 0.90$). The remaining disagreements were discussed and negotiated until a consensus was reached among the coders. With the robust number of codes, we sought to further categorize them under the theoretical guidance of the 7Ps Model (Kotler and Fox, 1995). We used the deductive content analysis approach to categorize the relevant codes under one of the 7Ps elements based on the code book and the theoretical definitions of the 7Ps model. The categorizations of all codes based on the 7Ps model, code definitions, and examples are presented in Table 1.

To answer RQ8, we utilized six relevant demographic variables from the study. We first recoded gender (0 = female,1 = male) and first-generation student status (0 = no, 1 = yes). We then recoded race to reflect racial minority (0 = White/Caucasian, 1 = other races). Age, family income, and GPA were treated as ordinal variables as they are collected as such. We then performed a series of crosstabulations between each binary demographic variable (i.e., gender, first-generation status, race) and the coded factors and used chi-square and p values to determine the relationships. We then performed a series of bivariate correlations between each ordinal demographic variable (i.e., age, family income, and GPA) and the coded factors and used Pearson coefficients and p-values to determine the relationships. All analyses were completed using SPSS 27.

4 Results

4.1 Engineering education factors

To answer RQ1a through RQ7a regarding the engineering education-specific factors that influence students' decisions, we conducted a mixed inductive and deductive content analysis. The results yielded a total of 25 codes reflecting a robust number of reasons why undergraduate engineering students choose a university/program. These codes included institutional standing, institutional culture, religion, school size, majors, safety, institutional curriculum, extracurricular activities, facilities, student resources, athletic, location, program standing, disciplinary related, length of study, research, career development, accreditation, program curriculum, faculty resources, tuition assistance program, merit-based aid, cost, employment opportunity, expected income, friends' influence, parents' influence, sibling's influence, and other family members' influence. For example, a student stated the reasons for choosing their university/program were, "I chose this university specifically because of its strong engineering program and the wide variety of majors it offered outside of engineering in case I switched majors. Also, I enjoyed the strong school spirit, football program, and variety of clubs it offered." This response was coded for the presence of five codes, including institutional culture, majors, extracurricular activities, athletic, and program standing. The definition of each code and examples are presented in Table 1.

In addition, we further categorized the 25 codes under one of the 7Ps elements based on the code book and the theoretical definitions of the 7Ps model. For example, the code Location was further categorized under the Place element of the 7Ps model. However, four codes fell outside the scope of the 7Ps, which are friends', parents', siblings', and other family members' influence. We categorized these four codes under a new element called Socialization.

4.2 Prevalence of engineering education factors

To answer RQ1b through RQ7b regarding the prevalence of each engineering education-specific factor that influences students' decisions, we present the frequency count of each code yielded from the thematic analysis. In total, 473 students presented a total of 946 reasons. The seven most frequently mentioned factors included Location (n = 142, 30%), Program standing (n = 108, 22.8%), Career development (n = 84, 17.8%), Athletic (n = 69, 14.6%), Institutional standing (n = 68, 14.5%), Majors (n = 62, 13.1%), and Cost (n = 59, 12.5%). Meanwhile, there are eight factors, including Religion, Safety, Length of study, Research, Friends' influences, Siblings' influences, other family's influences, and Expected income, all of which had fewer than 10 cases presented. Examining the border categorization of this code based on the 7Ps model elements, the most frequently mentioned element out of 946 responses was Promotion (n = 295, 31.2%); then followed by Program (n = 287, 30.0%), place (n = 173, 18.3%), price (n = 117, 12.4%), People (n = 54, 11.4%), Process (n = 34, 3.6%), Socialization (n = 29, 3.1%), and Physical evidence (n = 14, 1.5%). The results of the frequency count of each factor are presented in Table 2; within each 7Ps element, the factors are organized in descending order of the frequency count. To visually demonstrate the breakdown of the 7P model element and of the factors within each element, we present the frequency breakdowns using pie charts in Figures 1, 2.

4.3 Associations between demographic variables and engineering education factors

To answer RQ8 regarding the potential associations between demographic variables and engineering education factors, we present

TABLE 1 Choice factors organized by 7Ps model.

7Ps model elements	Engineer education factors	Definition	Examples from students
Program	Career development	Descriptions of opportunities or sources that could help students for career development: Alumni/industry network; Co-op/Internship opportunity	*Contains a large alumni network with many connections and chances following college for a successful career.*
	Majors	Descriptions of variety in majors offered by institution; offering engineering programs or a specific engineering major	*[university name] offered the major I wanted*
	Disciplinary related	Descriptions of interests in engineering, a specific engineering field, or engineering-related skills.	*getting an undergraduate degree in mechanical engineering would be a great stepping stone to study aerospace in the future.*
	Program curriculum	Descriptions of engineering curriculum and course content	*I enjoy hands of learning and thought this was a good fit for me.*
	Employment opportunity	Description of job Opportunity; hiring rate; future prospect of a specific engineering field	*I chose this university less because of its academic rigor or job placement*
	Accreditation	Descriptions of Accreditation, specifically related to ABET	*It was ABET accredited*
	Student resources	Descriptions of any types of resources provided by the university for students; support from other non-faculty people	*[university name] gives you access to thousands of resources, programs, professionals, and friends.*
	Extracurricular activities	Description of extracurricular opportunities	*Also, I enjoyed the strong school spirit, football program, and variety of clubs it offered.*
	Research	Descriptions of research opportunities	*first year research opportunities*
Price	Cost	Description of living cost or cost in general	*Money it was not my first choice but money wise it won*
	Merit-based aid (e.g., scholarship)	Description of any type of scholarship	*Full tuition scholarship*
	Tuition assistance program	Descriptions of any types of assistance in tuition	*I am able to get free tuition because of it*
	Expected income	Descriptions of expectations in future income	*I know by graduating I will have a secure future with good income*
Place	Location	Descriptions of campus location; proximity to home	*close enough to home*
	Institutional culture	Description of how students feel about campus and environment	*Great student atmosphere*
	Safety	Descriptions of safety-related to campus location, safe environment on campus, and sense of safety	*Also this campus was closer and felt safer than others that I had visited.*
Promotion	Program standing	Descriptions of program ranking; Program reputation	*Ranked high among public engineering schools.*
	Athletic	Descriptions of athletic reputations; Opportunities to play sports	*I chose this university to play baseball at the collegiate level in Ohio as well as study engineering.*
	Institutional standing	Descriptions of institutional ranking; institutional reputation; Types of institution;	*It was similarly ranked to all the other schools that i had chosen*
	School size	Descriptions of the size of the campus, the size of overall student populations	*Small campus*
	Religion	Descriptions of religious affiliation of institutions	*They are a Christian college*
People	Faculty resources	Descriptions of student-faculty ratio; class size; faculty reputation; descriptions of teaching and interactions with students	*because of the faculty of engineering staff here. I did a summer program and all the teachers where very kind and interacted with the students and really seemed like they cared about us.*
Physical evidence	Facilities	Description of quality of physical facilities on campus	*seemed to have good facilities in the engineering building*
Process	Institutional curriculum	Description of flexibility and variety in course selections	*I liked the opportunity to take classes with non-engineering majors to broaden my horizon.*
	Length of study	Description of duration of studies time to obtain degrees	*And I can go here and finish off my degree in 4 years instead of going to another school where i would have to transfer to a different school after my 2nd year.*

(Continued)

TABLE 1 (Continued)

7Ps model elements	Engineer education factors	Definition	Examples from students
Socialization	Parents' influence	Descriptions of influence or comments about the institution or program from mothers/fathers	*My father went to [university name] and we are a "[university name] Family."*
	Other family members' influence	Descriptions of influence or comments about the institution or program from other family members such as cousin	*I chose it because my cousin already came here*
	Sibling's influence	Descriptions of influence or comments about the institution or program from siblings	*both of my brothers attended here and studied engineering.*
	Friends' influence	Descriptions of influence or comments about the institution or program from friends	*I've heard good things from distant family members and friends about their program.*

the results of the chi-square tests and bivariate correlations. The chi-square test results showed that racial minority students were more likely to have Institutional curriculum ($\chi^2 = 5.13$, $p < 0.05$) and Tuition assistance program ($\chi^2 = 11.23$, $p < 0.001$), but less likely to have School size ($\chi^2 = 4.37$, $p < 0.05$), Location ($\chi^2 = 13.35$, $p < 0.001$), and Athletic ($\chi^2 = 6.55$, $p < 0.01$) as reasons why they chose their institution/program. The results showed female students were more likely to have Majors ($\chi^2 = 7.50$, $p < 0.01$), Safety ($\chi^2 = 7.15$, $p < 0.01$), and Institutional curriculum ($\chi^2 = 4.72$, $p < 0.05$) but less likely to have School size ($\chi^2 = 4.37$, $p < 0.05$), Location ($\chi^2 = 4.60$, $p < 0.05$), and Athletic ($\chi^2 = 12.27$, $p < 0.001$) as reasons why they chose their institution/program. Lastly, the results showed that first-generation students were more likely to have Tuition assistance programs ($\chi^2 = 7.16$, $p < 0.01$) but less likely to have Program curriculum ($\chi^2 = 3.86$, $p < 0.05$) as reasons why they chose their institution/program.

The bivariate correlation results showed that older age was positively associated with having Research ($r = 0.17$, $p < 0.001$) and higher Expected income ($r = 0.11$, $p < 0.05$) as reasons why they chose their institution/program; higher family income was positively associated with having School size ($r = 0.12$, $p < 0.05$), Extracurricular activities ($r = 0.10$, $p < 0.05$), and Athletic ($r = 0.13$, $p < 0.01$), but was negatively associated with having Faculty resources ($r = 0.09$, $p < 0.05$) as reasons why they chose their institution/program; higher GPA was negatively associated with having Athletic ($r = -0.16$, $p < 0.001$), but was positively associated with having Career development ($r = 0.09$, $p < 0.05$) as reasons why they chose their institution/program. The full results of the chi-square tests and bivariate correlations are presented in Table 2.

5 Discussion

Higher education is (and should be) not the same experience for everyone, which is why the process of making a choice is often characterized by its complexity and the variety of factors that impact the decision. The current literature in engineering undergraduate education primarily focuses on identifying factors that affect students' selection of engineering majors, without considering the aspects that influence their choice of universities or programs (Main et al., 2022). To fill this gap, this research aims to comprehensively identify the factors that influence the decision-making process through a mixed inductive and deductive content analysis using seven elements from the 7Ps model (Kotler and Fox, 1995) as the guiding theoretical framework (Kyngäs, 2020). It is essential to note that other theoretical models, such as Expectancy-Value Theory (Eccles, 1983), the Theory of Planned Behavior (Ajzen, 1991), or Self-Determination Theory (Deci and Ryan, 2012), have informed the elements of the 7P model and also the current study. The following discussion highlights some of the intriguing results that carry practical implications for university strategic planning, faculty performance, and program design. We hope such a discussion could lead to a better understanding of the students, which could yield better utilization of resources and strategic positioning for engineering programs.

5.1 What matters to students?

As illustrated in Figure 1, which shows the distribution of 7P model elements, Promotion and Program-related factors were the most frequently referenced. Firstly, Location was a prevalent theme among the students' responses. We jokingly discussed that this practice was like a real estate purchase. As such, choosing a program is highly individualized for students, as many students choose the school because of its proximity to their homes. Location is a factor derived from the element Place in the 7Ps model, which is sometimes an underestimated aspect of the overall marketing picture. Thus, leveraging the location could be one of the most critical marketing strategies for higher education institutes toward enrollment growth (Winter and Thompson-Whiteside, 2017). The location could be the most differentiating element that frames an institute's market position (Hanna and Rowley, 2008). Institutions should explore ways to incorporate their location more fully into the narrative when building up their reputation. Whether the campus is rural, urban, or somewhere in between, an institution can utilize place branding for its benefit. The rural location might offer more opportunities for natural sciences and service learning in settings where student work will be truly noticed and utilized (Zastoupil, 2022). On the other hand, an urban setting could provide easy access to cultural, professional, and social engagements for students, such as readily available internships and public transit options that enable them to pursue these opportunities (Fumasoli et al., 2020). Urban areas typically host multiple college and university campuses, which provide chances for sharing resources, classes, and social gatherings (Trencher et al., 2014; Salama and Hinton, 2023). However, location is not an intervenable factor that an institution could (at least, easily) change. Even though location was the most frequently mentioned factor by students, as

TABLE 2 Frequency counts and associations with demographic factors.

7Ps model elements	Engineer education factors	Frequency count by factor	Frequency count by element[1]	χ^2 with race	χ^2 with gender	χ^2 with first-generation	r with age	r with family income	r with GPA
Program	Career development	84 (17.8%)	284 (30.0%)	0.40, p = 0.53	0.44, p = 0.51	0.22, p = 0.64	−0.05, p = 0.26	−0.05, p = 0.29	0.09*
	Majors	61 (13.1%)		0.70, p = 0.40	7.50**	2.51, p = 0.11	−0.04, p = 0.46	0.06, p = 0.23	0.05, p = 0.30
	Disciplinary related	33 (7.0%)		2.31, p = 0.13	2.16, p = 0.14	2.60, p = 0.11	−0.03, p = 0.51	0.03, p = 0.52	0.01, p = 0.92
	Program curriculum	33 (7.0%)		1.40, p = 0.24	0.51, p = 0.47	3.85*	−0.07, p = 0.16	0.09, p = 0.07	0.04, p = 0.37
	Employment opportunity	21 (4.4%)		0.99, p = 0.32	1.43, p = 0.23	0.47, p = 0.49	−0.06, p = 0.23	0.03, p = 0.53	0.02, p = 0.70
	Accreditation	19 (4.0%)		1.13, p = 0.29	0.17, p = 0.68	0.27, p = 0.60	−0.05, p = 0.30	0.03, p = 0.60	−0.04, p = 0.35
	Student resources	16 (3.4%)		1.29, p = 0.26	0.02, p = 0.90	0.06, p = 0.80	−0.05, p = 0.34	−0.01, p = 0.79	−0.01, p = 0.87
	Extracurricular activities	10 (2.1%)		0.01, p = 0.99	0.07, p = 0.79	0.23, p = 0.63	−0.01, p = 0.77	0.06, p = 0.22	0.04, p = 0.43
	Research	7 (1.5%)		2.30, p = 0.13	3.85*	1.09, p = 0.30	0.17***	−0.01, p = 0.83	0.07, p = 0.17
Price	Cost	59 (12.5%)	117 (12.4%)	0.98, p = 0.32	3.80, p = 0.05	2.08, p = 0.15	−0.02, p = 0.65	0.01, p = 0.87	0.02, p = 0.60
	Merit-based aid (e.g., scholarship)	44 (9.3%)		1.26, p = 0.26	1.07, p = 0.30	0.04, p = 0.84	−0.08, p = 0.10	−0.02, p = 0.61	0.07, p = 0.14
	Tuition assistance program	12 (2.5%)		11.23***	0.66, p = 0.42	7.16**	−0.03, p = 0.52	−0.01, p = 0.85	0.02, p = 0.60
	Expected income	2 (0.4%)		1.12, p = 0.29	1.13, p = 0.29	0.35, p = 0.56	0.11*	−0.04, p = 0.37	−0.08, p = 0.07
Place	Location	142 (30.0%)	173 (18.3%)	13.35***	4.60*	0.06, p = 0.81	0.09, p = 0.06	−0.03, p = 0.55	0.05, p = 0.26
	Institutional culture	27 (5.7%)		0.03, p = 0.87	0.52, p = 0.47	0.90, p = 0.34	−0.06, p = 0.17	0.05, p = 0.30	0.06, p = 0.18
	Safety	4 (0.8%)		1.01, p = 0.31	7.15**	0.70, p = 0.41	−0.02, p = 0.76	−0.04, p = 0.47	−0.04, p = 0.36
Promotion	Program standing	108 (22.9%)	295 (31.2%)	1.66, p = 0.20	0.46, p = 0.50	0.33, p = 0.56	−0.04, p = 0.41	−0.02, p = 0.65	0.01, p = 0.95
	Athletic	69 (14.6%)		6.5*	12.27***	0.62, p = 0.43	−0.09, p = 0.06	0.13**	−0.16***
	Institutional standing	68 (14.4%)		0.19, p = 0.66	1.50, p = 0.22	0.13, p = 0.71	−0.08, p = 0.11	0.07, p = 0.12	0.01, p = 0.79
	School size	47 (9.9%)		4.37*	2.62, p = 0.11	0.15, p = 0.70	−0.02, p = 0.65	0.11*	0.08, p = 0.07
	Religion	3 (0.6%)		0.33, p = 0.56	1.23, p = 0.27	0.52, p = 0.47	−0.02, p = 0.72	−0.03, p = 0.48	0.01, p = 0.79
People	Faculty resources	54 (11.4%)	54 (5.7%)	0.01, p = 0.96	1.82, p = 0.18	0.01, p = 0.98	−0.09, p = 0.07	0.08, p = 0.07	−0.03, p = 0.52
Physical evidence	Facilities	14 (3.0%)	14 (1.5%)	3.63, p = 0.06	1.34, p = 0.25	2.49, p = 0.12	−0.06, p = 0.23	0.10*	−0.01, p = 0.76
Process	Institutional curriculum	27 (5.7%)	34 (3.6%)	5.13*	4.72*	1.30, p = 0.25	0.03, p = 0.47	0.05, p = 0.33	0.08, p = 0.07
	Length of study	6 (1.3%)		1.53, p = 0.22	1.00, p = 0.32	0.02, p = 0.89	−0.04, p = 0.36	0.07, p = 0.13	−0.07, p = 0.14
	Parents' influence	15 (3.2%)		0.44, p = 0.51	0.76, p = 0.39	0.80, p = 0.37	0.02, p = 0.70	0.05, p = 0.25	0.02, p = 0.62
Socialization	Other family members' influence	6 (1.3%)	29 (3.1%)	0.67, p = 0.42	2.47, p = 0.12	0.02, p = 0.89	0.01, p = 0.78	−0.08, p = 0.08	−0.08, p = 0.09
	Sibling's influence	5 (1.1%)		1.27, p = 0.26	0.03, p = 0.85	0.87, p = 0.35	0.02, p = 0.67	0.06, p = 0.25	−0.04, p = 0.35
	Friends' influence	3 (0.6%)		12.01***	0.01, p = 0.92	4.51, p = 0.50	0.01, p = 0.99	−0.09, p = 0.05	0.02, p = 0.63

[1]The percentage was calculated based on the total number of responses from the survey (n = 946). *Indicates p < 0.05; ** indicates p < 0.01; *** indicates p < 0.001.

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illustrated in Figure 2, the flip side of the results showed that the vast majority of students (~70%) did not mention location as a deciding factor. Even though it was mentioned, it was usually coupled with other factors in our results. This warns institutions with advantageous locations to rely solely/heavily on their location in their branding, but more importantly, it highlights the feasibility and importance of other determining factors that universities should pay attention to, especially those located in less-than-ideal locations. Thus, the following discussion focuses on other determining factors beyond just the location that could be planned and intervened.

Secondly, program standing is another common theme among students' responses, as shown in Figure 2, a factor derived from the element Promotion in the 7Ps model. While the institution and Program standing and reputation tend to be condependent in most scenarios, the program standing and reputation seem to have a bit more sway on students' decisions in our results. Engineering programs focus on developing technical skills, critical thinking, and problem-solving abilities, all of which closely align with specific career paths (Mann et al., 2021). Engineering students tend to target particular industries or positions, making their career aspirations more tangible than those in fields with broader career options (Itani and Srour, 2016). Therefore, students interested in engineering generally have a clear career goal in mind when selecting institutions (Verdín et al., 2020). They are more inclined to prioritize the program's reputation when evaluating an institution. This suggests that institutions should make a greater effort to establish a distinct brand image for each engineering program to promote themselves to the recruitment market effectively, instead of leaning heavily on broader reputation and standing as a school. Institutions should tailor their promotional strategy and information to focus on showcasing the characteristics of a specific engineering discipline that align with a prospective student's interests, rather than presenting a general institutional standing overview. For example, institutions could host open-house events with different themes related to engineering, providing prospective students with opportunities to explore their academic offerings.

Lastly, related to promotion that is more focused at the program level, faculty and administrators should emphasize and promote achievements and plans that could align with students' career development objectives, which include high job placement rates, robust industry partnerships, and established alumni networks in technical fields (Borchert, 2002; Passow and Passow, 2017). This is supported by our results, as illustrated in Figure 2, which showed that Career development was the second most commonly mentioned determining factor. To implement and augment the current program design, faculty and administrators could integrate practical-based pedagogy, including project-based courses with engineering firms, hands-on experiences that align with professional skills, and course designs following industry standards (Forcael et al., 2022; Tembrevilla et al., 2024). By showcasing real-world problem-solving projects, programs can enhance their standing and branding and highlight the alignment between academic knowledge and workplace demands for prospective students (Trevelyan, 2019). Outside the classroom, institutions should promote co-op programs and related metrics such as job placement rates (Ferns et al., 2019). Not only should institutions provide information on their websites or through talks, but they should also consider inviting industry partners to campus visits to demonstrate collaborations with students and communicate with prospective students (Avrithi and Clagett, 2024).

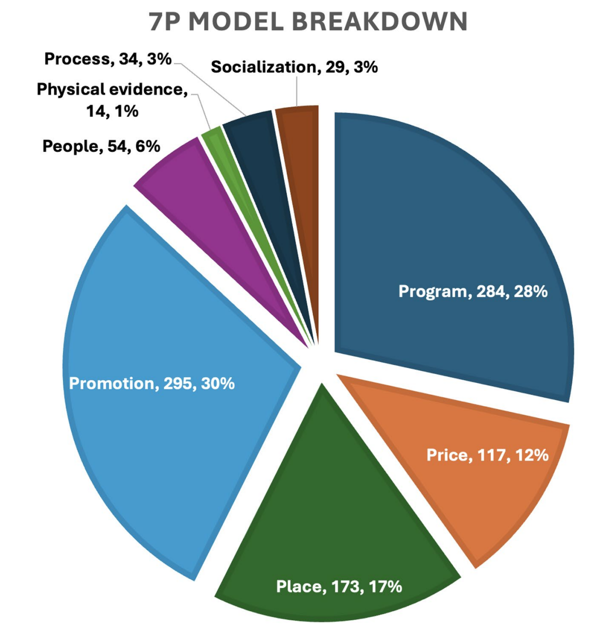

FIGURE 1
Distribution of 7P model elements.

5.2 What seems to matter less?

Meanwhile, there are multiple factors that students seem to be less concerned about when making decisions. These results could have implications for strategic planning and program design, as higher education continues to compete for scarce resources. As illustrated in Figure 1, the newly added element of Socialization, defined as the influence of people in students' social circles, including parents, siblings, friends, and other family members, is not as heavily weighted as previous literature suggested. Family influence generally has a positive effect on students' careers and decision-making when selecting a university (Dustan, 2018; Koçak et al., 2021), although our data did not fully support this finding. It might be because students interested in engineering have more autonomy in their academic choices. As discussed earlier, engineering students have a clear career goal in mind, which means they are more likely to be confident in making independent decisions. Additionally, the student participants in this study are primarily Generation Z students born between 1995 and 2012. Students from this generation may seek greater autonomy and independence from their parents than those from earlier generations (Salvadorinho et al., 2024). An emphasis on individualism may lead them to value their personal goal over family expectations. Moreover, technology has significantly impacted the methods Generation Z students use to collect information and engage in social interactions (Janssen and Carradini, 2021). They can be strongly influenced by social media and online communities, which often rival the influences of family. Therefore, personalized and digitally interactive marketing efforts utilizing social media might be a better

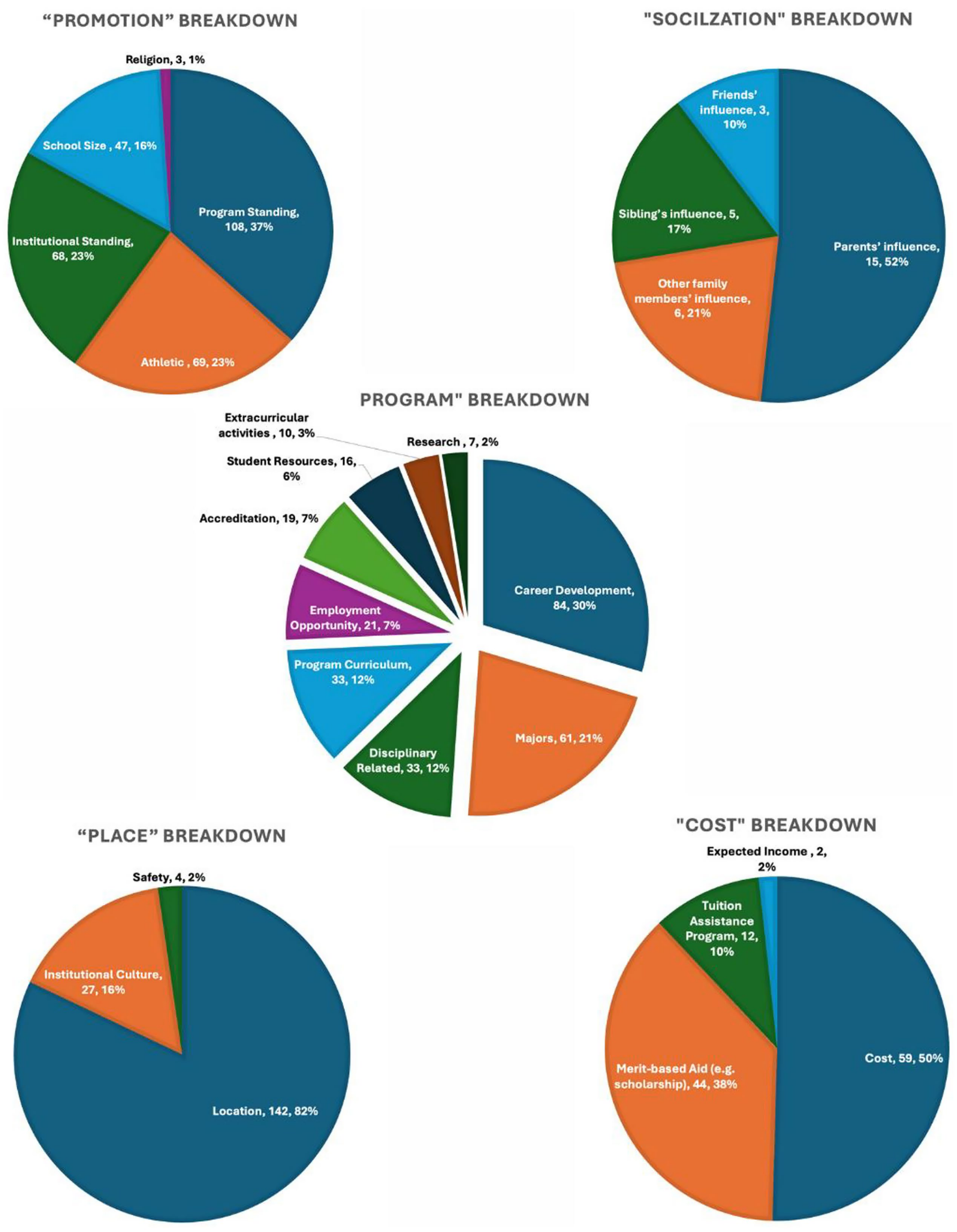

FIGURE 2
Frequency of individual factors in each 7P model element.

utilization of resources than traditional recruitment efforts, such as family visit day.

Second, very few students mentioned research opportunities offered by universities as factors influencing their decisions, as shown in Figure 2, despite the fact that many universities, particularly those with a research-intensive focus, invest significant effort in branding themselves through advanced research projects and highlighting groundbreaking discoveries and publications in prestigious journals (Callais and Lawson, 2025). One reason might be that students often lack a research background and related knowledge upon graduating from high school, and are therefore unfamiliar with or show less interest in research activities. This implies that institutions should explore alternative ways to utilize research as a brand in their efforts to recruit undergraduate students, rather than merely highlighting the research outcomes primarily achieved by faculty and graduate students. One effective means could be incorporating undergraduate research experience into program coursework, matching students' skill level, reflecting the practice of "meeting where students are." The emphasis could be on offering students opportunities to expand their understanding and knowledge of subject areas that may not be extensively covered in depth through regular courses (Miller et al., 2023). Engineering programs should tailor research experiences to match the appropriate level for enrolled students, ultimately shaping students' educational paths and career trajectories (Buchanan and Fisher, 2022). For instance, simple and guided research projects would be more suitable for introductory courses. Students can take such courses early in their degree program or in a summer outreach program, even while still in high school, to engage in research activities, learn fundamental scientific methods, build confidence and interests, and prepare themselves for higher-level courses that require more in-depth research endeavors (Beatty et al., 2021). Meanwhile, institutions and engineering programs could also utilize faculty research mentorship as a branding strategy, such as a freshman research scholarship program. Faculty mentors serve as role models for students, provide individualized support through mentoring relationships, and foster students' confidence in pursuing and persisting in their studies (Morales et al., 2016; Martin et al., 2024). Many studies have found that undergraduate students highly value the presence of a faculty mentor, as it can enhance their academic experience, career preparedness, and overall well-being (Holmgren and Sommers, 2024; Busch et al., 2024). Therefore, one-to-one faculty mentorship could attract students to participate in research projects that interest them (Fernández et al., 2024; Trolian et al., 2021).

Third, as illustrated in Figure 2, our results showed that the Length of study was less frequently mentioned in the current study. In practice, institutions typically use 4-year and 6-year graduation rates, expressed as the percentage of students who graduate within the designated period, as key measures of student success and their ability to prepare students for employment or advanced studies (Davidson, 2014). However, according to the result of the current study, engineering students appear to care less about the duration of their study time in the program, which could be due to various reasons. First, engineering students tend to prioritize obtaining their degree for career aspirations, making the duration of their studies less significant than the degree itself (Hahler and Orr, 2015). Second, it is common that students may take longer to obtain their degrees due to various circumstances (Witteveen and Attewell, 2021). For instance, many non-traditional students in urban areas may not be able to take the full course load necessary for graduating in four years (Brownie et al., 2025). Some freshman students may need to catch up on mathematics and physics classes to prepare for engineering studies (Steenkamp et al., 2017). Furthermore, students participating in co-op programs might choose to extend their college experience to gain more practical industry experience (Matusovich et al., 2019). Therefore, this suggests that institutions should adopt a more comprehensive approach to tracking student success and progress, rather than placing primary emphasis on graduation rates within a limited timeframe. In addition to metrics related to retention and graduation, institutions can analyze post-graduation outcomes by majors, which could encompass factors such as livable salaries and manageable debt levels (Wai and Tran, 2022). Moreover, these metrics can help institutions evaluate whether there is equity in student achievement across different institutions within the same area. As another alternative student success metric, institutions can use cohort data to assess how well equipped students are with skills that employers explicitly desire, such as technical proficiencies, communication skills, and specific management abilities (Jeswani, 2016). Institutions could market their engineering programs by showcasing how they minimize the skills gap between academia and industry, and highlighting feedback from both industry and students regarding the quality of education. Overall, it is crucial to avoid viewing and promoting individual student success metrics separately.

Lastly, students tend to be less focused on Expected income after graduation when selecting institutions to study, according to the results of the current study, as presented in Figure 2. It could be because engineering students assume that they will earn a high salary after graduation, considering the value they bring to the workforce and business (Fitzpatrick et al., 2023). However, previous studies have shown that undergraduate students often overestimate their starting salaries, regardless of their major (Diaz-Serrano and Nilsson, 2022; Dynarski et al., 2021). This phenomenon may stem from students' lack of insight into their own values, preferences, and abilities, which can lead to unrealistic views about employment opportunities (Purnama and Asdlori, 2023). Moreover, previous research has indicated that students' views on employment extend beyond merely salary. They are also concerned with career development, unemployment risks, working hours, and the availability of resources (Boneva et al., 2022). Therefore, institutions should avoid placing too much emphasis on potential income when they are marketing their programs. Instead, institutions should promote their career support and guidance for students and paint a broader picture of the field. Such services should help students identify their aspirations and skill gaps, explore various career options, gain a realistic understanding of job market trends, and eventually help shape their own career plans. In addition, establishing an industry mentorship program beyond the campus could also be an effective marketing strategy for institutions. A student can be paired with a mentor currently working in industry based on their experiences and interests. The mentors could serve as a voice of experience for students who need guidance navigating what it's like to search for positions, interview, and gain exposure to the types of jobs available.

To successfully attract potential engineering students, colleges and engineering programs should develop and adopt a holistic marketing and operating strategy that integrates signatures of each engineering discipline, grounded pedagogical teaching methods, and diverse student engagement. For example, by taking advantage of the location, programs could showcase the distinctiveness of each engineering field through interactions with local organizations and the natural environment. By developing partnerships with local industry, programs can boost their exposure by providing experiential learning or research opportunities that meet industry expectations and enhance students' engagement experience. Moreover, instead of using graduation statistics as the main indicator of student success, institutions should adopt a more comprehensive metric to map various areas of student success, such as feedback from the industry, students' feedback regarding the curriculum, and their study experiences with faculty. A storytelling strategy could be effective in marketing and enabling students to be interested in learning more about the institution or program.

5.3 Demographic factors and student choices

Our findings showed some intriguing differences in how two different groups of engineering students chose their universities/ programs, which consequently present an interesting paradox related to strategic planning and resource allocations to be considered. On one hand, many points of our findings related to the factors influencing minority students' choices align with previous research, which broadly examined undergraduate students in general. For example, previous studies showed that students interested in engineering, especially those who are racial minorities, first-generation students, and from low-income families, tend to focus more heavily on academic and professional considerations (Park et al., 2023; Park et al., 2025; Rulifson and Bielefeldt, 2017). Our findings largely align with these previous reports. Additionally, research highlights the significant role of financial aid in the college selection process for ethnic minority students, many of whom are first-generation college attendees (Kern, 2000). Our findings are consistent with the literature by showing that racial minority students were more likely to have Institutional curriculum and Tuition assistance programs, but less likely to cite School size, Location, and Athletics as reasons for choosing their university or program. However, on the other hand, our findings showed that White, male, and/or often affluent engineering students chose their universities based on non-academic experiences, such as athletics, campus culture, and location. For example, our findings showed that Athletics was frequently cited by White male students as a factor influencing their choices. These findings align with previous research, which shows that males participate in sports more frequently than females, typically at least twice as often in terms of frequency or duration (Deaner et al., 2016). This could be explained by the fact that male students tend to be more inclined than females to view competition and winning as primary reasons for participating in sports (Rapport et al., 2018). Likewise, the lower participation rate of females, especially underrepresented female students, in sports predominantly stems from their greater emphasis on academic pursuits (Deaner et al., 2012). Additionally, athletics can significantly influence the development of campus culture (Allen et al., 2010). For many students today, attending sports games is an essential part of their college experience (Jayakumar and Comeaux, 2016; Shabani et al., 2022).

Thus, this brings the intriguing paradox of strategic planning and resource allocations related to student demographics. An important group of engineering students might feel left out if resources have been heavily focused on promoting non-academic factors, such as athletics. Sports undoubtedly have merit in that they provide students the opportunity to engage in healthy, competitive activities that they are enthusiastic about (Kim et al., 2023). However, to boost enrollment figures, institutions should adopt an effective strategy to balance athletics and academics. A strategy that could focus on promoting a blend of academics, sports, and campus experiences to meet the diverse needs of prospective students (Judson et al., 2004; Huml et al., 2019). Institutions could create and promote a support framework to incorporate sports into the academic setting. Sport-themed materials can be integrated into teaching and research projects. Athletic mindsets can be utilized to support academic achievements in students' educational paths. For instance, in the classroom, teachers can foster a "Team" learning approach by forming study groups that resemble sports teams, focusing on collaboration, accountability, and shared success. Students with strong academic skills can be paired with those who require additional support, establishing a mentorship dynamic similar to that of a sports team. Furthermore, institutions can emphasize the holistic benefits of sports, such as improved cognitive skills, leadership mindsets, social competencies, and teamwork, while offering a variety of sports options to appeal to various interests, particularly among minority students. Institutions should integrate these benefits, not viewing them as mutually exclusive, thus boosting their reputation as a place where both academic and athletic excellence thrive.

6 Limitations

The current study should be interpreted with its limitations. First, the study did not measure the weight or magnitude by adding a quantitative scale to measure each factor. This was unfortunately beyond the scope and resources of the current project. Our main aim was to gather a comprehensive picture of what might come together and influence engineering students' decisions, but future research could further explain the weights of each influence by asking students to rate each factor. Second, we included students across different stages of study (i.e., from freshmen to seniors), and some recall of the reasons behind their choices might have experienced a prolonged period of time gap. This recall might not exactly match their original reasons due to the time lag and their lived experiences at that university, which could introduce recall bias. Nevertheless, the findings still offered valuable insights into this important topic, but future studies could consider conducting a cohort-based study at a specific time of students' studying (e.g., at the beginning of their first semester). Lastly, recruiting a nationwide sample was resource-prohibitive for the current project. It is important to acknowledge that engineering students from different regions of the United States and different countries might present different findings, which future research should explore.

7 Conclusion

With rapidly changing student demographics and the higher education landscape in the United States, it is imperative that a successful school and Program understand and implement necessary changes while keeping limited resources in mind. We hope our results provide a focused lens on why engineering students choose one school or program over others and also offer practical suggestions for schools and programs to evolve, survive, and thrive in any location.

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/s.

Ethics statement

The studies involving humans were approved by the Institutional Review Board (IRB 2021–482) at the University of Mount Union. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

XW: Conceptualization, Data curation, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing. MD: Conceptualization, Data curation, Formal analysis, Methodology, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. RM: Data curation, Validation, Writing – original draft, Writing – review & editing. TZ: Writing – original draft, Writing – review & editing. NM: Writing – original draft, 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.

Generative AI statement

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