

Civil Engineering Students' Perceptions of Public Sector Transportation Roles during Search for Full-Time Employment

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Abstract

A well-developed transportation engineering workforce is essential to adequately address current transportation infrastructure needs in the United States. However, there is a discrepancy between the existing need for more next-generation talent in public sector transportation engineering and the ability of public agencies to recruit new civil engineering graduates to adequately fill these roles. The growing necessity for strategies to attract and retain a skilled and diverse transportation workforce in the public sector has been identified as a critical current issue in the U.S. transportation industry. State Departments of Transportation (DOTs) across the U.S. have commonly described difficulties in the recruitment and retention of young talent in public sector transportation engineering roles. Despite this need, there has not been extensive research conducted on how state DOTs can better attract and retain newly graduated engineers in public sector roles. There exists a general lack of understanding of civil engineering students' current perspectives on public sector engineering positions and the factors that may attract or detract them from considering these roles. The purpose of this study was to identify the factors that senior civil engineering students find most important during their search for full-time employment and investigate their perceptions regarding public sector transportation engineering roles, specifically at state DOTs. Semi-structured interviews were conducted with 18 undergraduate students in their last year of civil engineering or a related degree program at two midwestern universities. Students were recruited from senior-level capstone design courses to discuss their job searches and perspectives on public sector or DOT roles. Researchers used inductive coding and thematic analysis to identify primary themes in student responses regarding important factors in their job search and perceptions of public sector civil engineering roles as they prepare to transition into industry positions. The results of this study will inform strategies for state DOTs to recruit and retain new civil engineering talent in public sector roles as well as provide insights for engineering educators to support civil engineering students more comprehensively in their search for full-time employment after graduation. Future work will combine the themes developed in this study with data from interviews with civil engineers working in both the private and public sector to inform the development of a nationwide survey for a more comprehensive understanding of factors that attract or detract engineers from public sector transportation roles.

I. Introduction

Current transportation infrastructure needs in the United States necessitate a well-developed civil and transportation engineering workforce in the public sector [1]. State Departments of Transportation (DOTs) are critical organizations to ensure safe, efficient, and effective design, construction, and maintenance of U.S. infrastructure, requiring a labor force diverse in age, background, and expertise [1], [2]. However, state DOTs are struggling to effectively recruit and retain the new civil engineering talent needed to adequately support the transportation infrastructure needs projected for the coming decade [3], [4], [5]. Public transportation agencies have commonly described difficulties maintaining a skilled and effective engineering workforce, often attributed to challenges such as aging personnel, difficulty in recruitment of young engineers, and inability to competitively match engineering salaries in the private sector [2]. DOT officials have identified a workforce crisis in the transportation industry in the public sector, highlighting the need to increase workforce diversity [6]. Senior engineers continue to retire at higher rates than new engineers can be recruited, with 34% of state employees projected to be eligible for retirement within the next five years [7]. The necessity for strategies to effectively attract, train, and retain a robust engineering workforce in the public sector has been identified as one of the most critical current issues in infrastructure by the U.S. Transportation Research Board [2].

There is a growing need to identify how state DOTs and other public agencies in the transportation industry can adequately recruit new talent despite difficulties providing salaries competitive with those in the private sector. However, there is little existing research on the factors and perceptions that lead current civil engineering students to consider positions in either the private or public sector. To best understand how civil engineering employers in the public sector, specifically state DOTs, can better interact with, recruit, and retain new engineers, it is first necessary to understand the general considerations that are most important to today's civil engineering students during their job search and how state DOT roles are currently perceived by newly graduated engineers looking for full-time positions. The purpose of this study was to understand the factors that senior civil engineering students find most meaningful during their search for full-time employment and investigate student perceptions regarding public sector transportation engineering positions. Findings will inform recruitment strategies for state DOTs and university partnerships with public agencies to address the need for new civil engineering talent in the public sector.

II. Background

Navigating the Job Search as a Civil Engineering Student. Past literature has contributed to our understanding of students' challenges and preferences during the search for career placement in engineering. Civil engineering students have previously described challenges during their full-time job search due to various factors, including a lack of alignment with interests or location, not enjoying internship experiences, or issues with timeline of responses or job offers; these barriers offer some insight into specific considerations that matter to civil engineering students as they pursue employment [8]. Further research investigating influential factors in job selections indicated that urban job locations, job challenge level, and supportive leadership were among the top qualities in careers pursued by STEM students in Ghana [9], while a recent study of construction management students in the United States has identified a shift towards young

professionals seeking work-life balance and a fulfilling career to a similar extent as they do adequate compensation in today's job market [10]. From current literature, it can be observed that the priorities of STEM students during job selection extend beyond the sole consideration of financial stability. Additionally, some prior research has investigated predictors of engineering student interest in the government sector and public policy work, with results indicating that career interests (e.g., addressing terrorism/war, climate change) are predictive factors for student entry into public sector careers [11].

Other studies have explored general student perceptions toward the transportation industry, often without a focus on careers in engineering or the public sector specifically. A 2004 survey elicited student perceptions regarding general careers in the transportation industry and found that those who expressed interest in the industry valued achievement and career growth opportunities, competitive benefits, and career stability/security; however, as participants were not limited to engineering disciplines, survey respondents in this study primarily referenced these factors with regard to careers such as truck driver, airline pilot, ship captain, or train driver in the transportation industry [12]. Furthermore, a 2009 study on how students choose transportation-specialized careers in civil engineering (in both the private and public sectors) indicated a need for greater efforts in higher education to inform students of the breadth of transportation engineering professions [13], and survey data collected from students of all majors in 2010 suggested that students generally held negative attitudes about internships and careers in public transportation [14]. There has been little research within the past decade, however, exploring current-day student perspectives on factors that influence civil engineers' career decisions regarding state transportation departments.

Recruitment and Retention Efforts in the Public Sector. Prior research has investigated the existing workforce challenges experienced by state DOTs and the effectiveness of current recruitment and retention efforts for these roles in the public sector. In 2001, a survey of personnel at nine state DOTs was conducted in an attempt to address the workforce shortage in the public sector and understand recruitment strategies used to attract engineers to DOT roles; results indicated that, while DOTs are often unable to financially compete with the private sector, attempts to highlight factors such as job variety, family life, and job security were viewed by DOT respondents as effective recruitment [15]. More recent interviews with state DOT human resources employees have revealed that civil engineers are among the positions most difficult to fill at state transportation agencies and high turnover rates, with this difficulty most often attributed to salary discrepancies in relation to private consulting firms [5], [7]. These interviews then informed the development and distribution of a broader survey of current state DOT employees across the same five states to identify the most effective recruitment appeals; the resulting elements that attracted DOT employees most effectively included retirement benefits, job stability, health benefits, work appeal, vacation/leave, and professional development opportunities [5], [7]. While the 2001 exploration of this problem indicated that state DOTs were typically satisfied with their retention of staff within civil engineering positions [15], research from two decades later has noted significant challenges in retention of DOT employees [5], suggesting a persisting need to further address both recruitment and retention challenges in public sector engineering positions through innovative strategies. Furthermore, research from another state DOT investigating workforce shortages has identified three strengths in incentivizing careers in public transportation: job stability, competitive benefits, and organizational culture [16]. Despite these existing incentives, it has been recommended that

DOTs increase focus on targeted outreach and mentorship with college students to improve effectiveness of recruitment strategies [16]. While some research exists on the perceptions of state DOT employees regarding recruitment and retention efforts for engineering positions from an employer perspective, there is little research on the effectiveness of state DOT and public agency recruitment efforts from the perspective of current civil engineering students as they consider various full-time employment opportunities.

III. Research Purpose & Questions

The purpose of this study was to understand the factors that senior civil engineering students find most meaningful during their search for full-time employment and investigate student perceptions regarding public sector transportation engineering positions. This research addresses the following questions:

1. What factors are most important to civil engineering students during their search for a full-time position?
2. What are current civil engineering students' perceptions of public sector engineering and state DOTs?

IV. Methods

A. Setting & Participants

This study employed a qualitative approach to address these research questions. Participants in this study were 18 students majoring in civil engineering, construction engineering/management, or environmental engineering from two Midwest universities. Students were recruited for participation in this study from senior-level capstone courses in civil engineering and construction engineering/management. Participating students were all expected to graduate with their undergraduate degree within the next year. Table 1 displays aggregate demographic data collected from participants, including gender, race, and field of study. Of the 18 total participants, 15 students were majoring in civil engineering.

Table 1. Aggregate Participant Demographic Information

Category	Value	<i>n</i>
Gender	Female	8
	Male	10
Race/Ethnicity	Asian	1
	Hispanic or Latino	4
	White	13
University	University 1 (Midwest R1)	13
	University 2 (Midwest R2)	5
Major	Civil Engineering	15
	Construction Engineering	1
	Construction Management	1
	Environmental Engineering	1

B. Data Collection

Interviews were conducted with student participants via Zoom software, which captured audio recordings and transcriptions for each interview. The interview protocol was semi-structured with guiding questions to lead discussion but allowed for additional questions to prompt participants to elaborate on perceptions or describe experiences in more detail. Examples of interview questions include “What considerations are most important to you in your job search?” or “How do your peers or classmates generally feel about DOTs or public sector jobs?” Participants were consistently prompted to describe their job search in civil engineering, the factors that drive their full-time position decisions, and their understanding of engineering positions in the public sector. The research team validated and cleaned all interview transcripts of filler words and false starts before analysis began.

C. Data Analysis

Student interview transcripts were iteratively analyzed by open inductive coding followed by a systematic thematic analysis to identify (1) factors that civil engineering students find important when considering full-time employment positions, and (2) student perceptions of public sector engineering and positions at state DOTs. Researchers engaged with interview transcripts by reading through them one at a time, highlighting and annotating sections relevant to the research questions, and iteratively applying open coding. In total, 44 codes resulted in the first round of coding for factors that students find most important in their job searches, and 26 codes emerged for student perceptions of the public sector and/or state DOT jobs in the subsequent round of coding. Codes were determined by an open coding approach in which labels were developed inductively from the data to capture patterns. Once all transcripts were coded, the resulting codes were then organized into themes consistently observed in the data. This process of analysis was informed by the method of thematic analysis defined by Braun & Clarke [17].

V. Results

A. Factors that Influence Civil Engineering Students' Job Considerations

Participants in this study articulated a wide variety of factors that, in their experience, influenced their consideration of various full-time civil engineering opportunities during their job search. While six total themes emerged within this focus of analysis, two prominent themes that were considered most relevant to employers' recruitment strategies will be discussed in this paper: (1) the *perceived reputation* of or *impression* made by an employer, and (2) demonstration of *flexibility* and *work-life balance* in a position. Further insights from the remaining emergent themes will be discussed in future works of dissemination for this project.

Perceived Reputation and Impression. Many participants articulated that an employer's reputation or impression they perceived or experienced, whether a private company or public agency, played a role in their consideration of that employer for a full-time position. From students' descriptions of their job search experiences, a positive depiction of the company developed through conversations with others was a critical factor as students considered full-time opportunities. When describing the company that she had interned with and decided to sign on with full-time, Student 1 explained, "[I had] heard good things about them, had heard different people who had worked for them and talked about how much they liked them, and so I went to the career fair, and, they were, I think, my favorite company that I talked to." In this depiction, Student 1 discusses that she had heard others speak positively about their chosen company, and this perceived reputation prompted her to approach this company at a career fair for an internship and eventually accept a full-time position. Student 6 assented with this idea that a company's reputation and initial impressions held weight during his job search, stating:

"I went to the career fair and then started looking into the places that I had spoken with. I looked at their websites, you know, how is their corporation structured? The things that they put out in the world that seemed to give them a sense of identity mattered to me, and there were certainly places where I went to the site, or had interactions with, and had just, like, immediately said, 'not interested'."

For both Students 1 and 6, the career fair event provided an opportunity for companies to make an impression on students as a potential employer; Student 6 builds on this idea by explaining that the way the company presented itself through other avenues, such as the website and interpersonal interactions with employees, revealed relevant information to him about the fit of that employer as a career he would be interested in long-term. The company's reputation, not only from the mouths of others but from impressions made by the company itself, was a prominent factor in students' job considerations.

For many students, internship experiences additionally allowed crucial insights into an employer's reputation among their employees that acted as a persuasive agent in their career decisions. When speaking about his internship experience with an engineering firm, Student 10 articulated:

"I personally didn't really enjoy that internship as much, just because that firm ... seemed very unorganized with how they brought on interns, like I wasn't really kept up to date with everything that was going on, and my mentor wasn't really too present. Even just hearing it from other engineers, they complained about the

company all the time in front of me. Which is like, why are you complaining in front of an intern, you know? You want them to come on full-time.”

This statement indicates the value that Student 10 placed in considering the opinions of current employees when contemplating the reputation of the company. He describes a negative impression of the internship program he experienced as well as a negative perception of the company’s reputation due to complaints he observed from currently employed engineers, dissuading him from considering the company for a full-time engineering position.

Flexibility and Work-Life Balance. Students often expressed that an employer’s ability to demonstrate flexibility and offer work-life balance in a position played a significant role during their job search. “To be quite frank, I don't love the idea of working at [current internship] full-time after graduation. I think it'll be nice to have it. Like, if for some reason that's the only offer I get, then, I'll obviously take it, but it's kind of lacking that work-life balance ... I see how stressed out my coworkers are, and they just seem as if they keep taking on projects but don't exactly look at how many employees they have and take that into account.” This statement from Student 11 conveys a sentiment shared by several other participants: she is looking for companies that can provide her with a sense of balance between personal life (family, physical and mental health, leisure, etc.) and job responsibilities through indications of flexibility and adaptability. During Student 11’s internship, she perceived high levels of stress among the engineers she worked alongside, interpreted this observation as a lack of work-life balance provided in roles at this company, and indicated that this factor negatively impacted her desire to pursue a full-time position at this company.

Furthermore, Student 6 discussed the importance of work-life balance in terms of family responsibilities and the need for employers to exhibit flexibility. “For instance, in [current internship], a lot of the folks have kids and so do I, and so there's a real acceptance for working from home and flexibility with schedules as long as projects get done. It’s not, like, you have to be here at 7:30 and you can't leave ‘til 5. I think it used to be that way, from what I understand, but it's much more flexible now, and so that's something that's important.” To Student 6, his employer’s ability to adapt and demonstrate flexibility with working hours was a significant factor in his job search due to responsibilities in his personal life involving kids and family. Other students cited a company’s flexibility in terms of academic responsibilities as particularly important to them, with Student 7 explaining, “I think them [being] willing to change your schedule, or just work around your schedule, and respect school for you - I think that's important.” From these accounts, it became clear that several students valued demonstrations of flexibility regarding obligations outside of work and considered this attribute to be significant when considering companies for full-time employment.

B. Student Perceptions of Public Sector Engineering and State DOTs

In the second round of coding, student perspectives on public sector opportunities in civil engineering were analyzed. From this iteration of analysis, five themes emerged, and three of the most prominent themes will be discussed here in detail. Many students did acknowledge their perception that salaries in the public sector were often not competitive with those in the private sector. Beyond that perspective, however, participant perceptions indicated that students generally feel as though (1) DOT jobs are *slow-paced* and *repetitive*, but *stable*; (2) DOTs offer

greater *flexibility* and *work-life balance* than private sector positions; and (3) students often *lack adequate exposure* to and *understanding* of state DOT roles.

DOT jobs are slow-paced and repetitive, but stable. When prompted about the general impressions that they and their classmates tend to hold regarding positions at DOTs, students generally agreed that they perceived DOTs to move slowly and require work of a repetitive nature, but that they are relatively stable jobs. Student 3 described his perspective that “things in the public sector I feel like, move a little bit slower ... if you work for a DOT, like, the problem's gonna be there tomorrow, it's gonna be there next week, it's gonna be there in a month,” while Student 1 echoed this sentiment that the public sector offers a “stable and less stressful, less high-paced environment.” The perception from these students indicated that they viewed DOTs as reliable and predictable positions; their understanding was that work would move more slowly without much variety in the responsibilities given to engineers in the public sector.

DOTs offer greater flexibility and work-life balance. Another prominent perception that emerged from analysis of student interview data was that students typically viewed state DOT jobs as offering greater flexibility and opportunities for work-life balance over positions in the private sector. Some of the students interviewed had previously held civil engineering internships in both the private and public sectors, which allowed them first-hand experience to offer comparisons on their perceptions regarding work-life balance within these two roles. When reflecting on his internship experience with a state DOT and comparing it to his experience in the private sector, Student 13 explained his perspective: “I felt like the culture was still the best from the DOT... from the other professional engineers there [private company], I could tell that a lot of them ... their work-life balance wasn't as good as that of those who worked at [state DOT] overall.” Student 11 expanded on this idea, coming to a similar conclusion during her internship in the public sector: “The work-life balance is really big. The paid time off was always really nice, and now being over in private sector, it's like, oh my gosh, you guys are busy all the time, you have no chill. And with government work, it was way more relaxed.” These insights reveal that these students generally viewed the culture and work-life balance in the public sector as a positive factor to consider. Students who were able to draw on both private and public sector experiences consistently perceived their public sector interactions and experiences as more flexible, less stressful, and more balanced between personal priorities and professional responsibilities.

For students who did not have first-hand internship experience with DOTs, similar sentiments regarding a general perception of flexibility and balance in DOT roles still emerged. Student 10 described his understanding that in the public sector, “you're going to have a little bit lower of a salary, but you might get better health insurance, you might get a pension, you might get more time off, more PTO. And then also, you get a better flexibility of what you can work on.” While recognizing that pay may be lower in the public sector than salaries available to engineers in the private sector, Student 10 perceives this disparity as addressed through greater benefits offered by DOT roles that provide work-life balance through greater time off and job flexibility.

Students often lack sufficient understanding of what DOT roles entail. A final perception that repeatedly surfaced during discussions with students was a lack of knowledge about DOT job opportunities or exposure to DOTs entirely. Student 5 expressed that, “I'm not too sure what opportunities there are for DOT, like, the day-to-day of what someone's job could be. Like, what positions they have,” and Student 8 shared a similar experience that, “Government work wasn't

necessarily something I ever really looked into, I guess ... I know it depends on the company, but I've heard that the pay can be better [in the private sector], but maybe with the government jobs, they have better benefits. But yeah, really no specific reason, I just didn't look into it.” These students described a general lack of knowledge about jobs in the public sector and at state DOTs, which was echoed by several other participants as well.

Students additionally articulated a perceived need for greater exposure to state DOTs or DOT representatives during their university experience. Student 6 voiced:

“I think that presence is important. I think that maybe it would be interesting if there were more discussion about what specific opportunities there are at the DOT, because I hear DOT, and I think, like, roads and bridges, which is probably somewhat accurate. But there's probably ... a lot of other sub-disciplines that they need or hire, so I wonder if in addition to the presence that they already have, if they also made an effort to explain or show students... sort of the breadth of what they do, and where students might fit in.”

This perspective reveals that, while this student has some understanding of DOT roles, he recognizes that he does not have a complete idea of the types of jobs and sub-disciplines employed by state DOTs; this idea of feeling unmotivated to apply for DOT jobs due to a general lack of knowledge about the variety of employment opportunities was consistently voiced by other students as well. Student 8 further detailed, “I know I was in a class, and they came in and spoke a couple times. I guess just more exposure in the classrooms or in clubs could be helpful.” While there has been some DOT exposure during these students’ undergraduate careers, these interactions were often not significantly memorable or influential in career choices.

VI. Discussion

The analysis of student experiences in this study provides new insights into how civil engineering students navigate their selection of a full-time position post-graduation with respect to consideration of public sector job opportunities. Two prominent factors valued by students during their job search that emerged were (1) the perceived reputation or impression of a potential employer and (2) an employer’s ability to demonstrate flexibility and work-life balance for its employees. When it comes to job flexibility (including flexible hours, flexible modes of work, etc.), the National Cooperative Highway Research Program (NCHRP) has supported state DOTs in implementing and maintaining flexible work arrangements (FWAs) beyond COVID-19 for employees, including the development of tools to track remote work arrangements and guidelines for effective implementation of flexible work options [18]. This study’s result that flexibility exhibited in the workplace is a key consideration of new civil engineers during their job search aligns well with current DOT and NCHRP policy structures that enable effective implementation of flexible work (including remote work options and hybrid schedules), indicating that discussion of FWAs during recruitment efforts may be more effective in attracting civil engineering students to DOT roles.

Furthermore, results of this study demonstrate that current civil engineering students hold prominent perceptions that: (1) DOT jobs are slow-paced and repetitive, but stable; (2) DOTs offer greater flexibility and work-life balance than roles in the private sector; and (3) students

often lack sufficient understanding of or exposure to DOTs. Student perceptions of job stability, flexibility, and work-life balance in state DOT roles were generally positive sentiments, while student descriptions of the slower pace and repetitive nature of work in the public sector tended to be delivered more critically. These findings align fairly well with current workforce development initiatives from Departments of Transportation and public agencies who employ civil engineers as they attempt to address workforce shortages in civil engineering while also indicating room for improvement. Several current U.S. DOT workforce planning initiatives emphasize the role of targeted engagement programs and transportation job preview opportunities for both high school and university students, citing a lack of transportation career awareness in primary education [19], [20], [21]. From existing workforce development efforts, it can be seen that DOTs have developed plans to address this lack of perception among students of public transportation agencies as viable career options through greater visibility in K-12 classrooms, locally focused transportation curriculum, and university partnerships [22], [23]. However, from the student perspectives in this study, there is still room for increased DOT visibility at the university level to increase student understanding of public sector job opportunities and their potential benefits. An understanding of the common perceptions toward state DOT roles that persist among civil engineering students allows for more targeted recruitment interventions and university interactions, especially when it comes to advertising factors such as work-life balance, flexibility, and job stability that students deemed attractive in full-time positions.

VII. Implications

The results of this study provide relevant implications for both state transportation departments and universities to better scaffold student pathways into public sector careers in civil engineering. First, it is recommended that a greater emphasis on work-life balance and job flexibility be implemented during interactions between university engineering students and public sector employers. The combination of findings from this study with prior literature indicates that students greatly value an employer's ability to demonstrate flexibility and adaptability in civil engineering roles, and state DOTs have the potential to highlight areas of roles that offer this work-life balance to engineers entering the workforce. Second, an increase in opportunities for students to interface with engineers in the public sector has the potential to attract more civil engineering students to DOT roles. These interactions can be implemented through increased DOT presence at events such as career fairs or professional and student organization meetings. Third, it is suggested that universities and civil engineering faculty partner with state DOT representatives for greater exposure to public sector work during undergraduate curriculum. From the findings of this study, the perception emerged that civil engineering students often lack sufficient understanding of the work variety offered and day-to-day responsibilities required by DOT roles. To address this deficiency, it is recommended that both state DOTs and universities implement avenues through which students are better exposed to public sector career pathways, whether through coursework, class presentations, career fairs, or industry recruitment events. Future work will combine the themes developed in this study with data from interviews with civil engineers working in both the private and public sector for a more comprehensive understanding of effective recruitment and retention strategies in civil

engineering roles. These results will inform the future development and distribution of a nationwide survey to gain a deeper insight into factors that attract or detract engineers from careers in the public sector.

VII. Limitations

One primary limitation of this study is that student participants were recruited solely from the midwestern region, limiting perceptions of the public sector to primarily Midwest DOTs; implications are not necessarily fully applicable to public or private employers outside of this region. As this study was conducted as the qualitative phase of a larger sequential mixed methods project, these results are not intended to be generalized to civil engineering students nationwide. Rather, findings provide useful insights for researchers and state DOTs on current student perspectives that can inform strategy recommendations, and results will be used as the foundation for the development of a nationwide survey to produce more generalizable findings about factors that attract or detract engineers to or from the public sector and DOT roles. It is additionally relevant to note that students who volunteered to participate in this study were predominantly white, and it is therefore possible that additional perceptions shaped by underrepresented racial or ethnic backgrounds were missed.

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