



## Exploring a Civil Engineer's Career Optimism

Sonia Reis; Jonathan Bunker, and Les Dawes.

*School of Civil and Environmental Engineering, Queensland University of Technology*

Corresponding Author's Email: [Sonia.Reis@qut.edu.au](mailto:Sonia.Reis@qut.edu.au)

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### ABSTRACT

#### CONTEXT

Internationally, evidence exists of a disconnection between the attainment of an engineering qualification and working as a professional engineer. The reasons for this are complex and not fully understood. To seek to improve the career optimism of a civil engineer we need to understand the factors impacting their decision about whether to remain in a professional engineering role.

#### PURPOSE

Our research aims to identify the factors affecting the career optimism of an Australian civil engineer. We expand upon the current research on engineers' career by analysing a wider demographic range, encompassing both gender and years of professional experience. Through the lens of the Theory of Work Adjustment, we aim to identify the significance of occupational and organisational values, adjustment and commitment, emphasising both individual and organisational factors.

#### APPROACH

A nationwide survey of Australian professional engineers was undertaken in 2021. Participants completed the 28 item Career Trajectory Survey questionnaire developed by the authors. Of the valid responses received, 235 were deemed to be professional civil engineers. Data collected were analysed using nonparametric statistical techniques to compare and contrast civil engineers' career optimism between demographic groups. Participants' demographics are identified by six categories: gender, years of experience, education level, industry, organisational size and geographic location.

#### OUTCOMES

An average of 62% of civil engineers reported career optimism, however, this varies significantly when contrasted by gender and experience. Of all civil engineering respondents, those most likely to report career optimism rate highest their *enjoyment of work and environment, collaboration, teamwork and communication, and practical engineering problem solving skills*. Other highly rated items include *self management and professionalism*, and the *need for relationships* within the work environment.

#### RECOMMENDATIONS

Our study offers valuable new insights into the career optimism of a wide range of Australian civil engineers. Career optimism has been positively linked to job performance, satisfaction, and work happiness. This research can be utilised to increase the career optimism of civil engineers, enabling them to remain in a professional engineering role.

**KEYWORDS** Civil Engineer, Career Optimism, Occupational Values

# Introduction

Infrastructure Australia predicts that demand for the infrastructure workforce, including civil engineers, is anticipated to soon reach unprecedented levels, with a 48% shortfall by 2023 (2021). An engineer's contribution to the economy is unique and indispensable, yet Australia has historically relied upon migrant engineers to fill labour market shortages (Department of Education and Training, 2020; Engineers Australia, 2019).

The reasons for engineers leaving the profession are complex and not fully understood (Mellors-Bourne, Connor, & Jackson, 2011). To seek to improve the career optimism of a civil engineer we need to understand the factors impacting a civil engineer's decision about whether to remain in a professional engineering role.

In this article, we present our Early Career Civil Engineer Trajectory Study, which is a unique investigation into the Career Optimism of Australian Civil Engineers (Reis, Bunker, & Dawes, 2020, 2021). This article examines the following research questions: What factors impact a civil engineer's optimism for a future in the engineering profession (RQ1)? Do these factors differ by gender or experience (RQ2)? With this research, we can support industry and engineering associations to build upon current supports provided to civil engineers, enabling them to remain in a professional engineering role.

## Understanding Civil Engineering Career Development

### Civil Engineering Career Contexts

Our literature review of engineering optimism, retention, turnover, barriers and supports has provided a better understanding of an engineer's career optimism, including predictors of, and barriers to, engineering persistence.

Predictors of engineering persistence include:

- engineering practice factors of problem-solving, collaboration and project management, increased by an individual's sense of attachment and belonging to engineering (Ayre, Mills, & Gill, 2013; Choe, Martins, Borrego, & Kendall, 2019),
- occupational values of achievement, status, and comfort (Fouad, Chang, Wan, & Singh, 2017),
- personal interests, exposure to professional networks, mentoring, and social cohesion (Brunhaver, Gilmartin, Chen, Matusovich, & Sheppard, 2015),
- appropriate organisational socialisation including a relatable mentor, networks, and socialisers (Korte, Brunhaver, & Zehr, 2019),
- complementing an individual's occupational needs with the occupational supports provided by the organisation (Hewlett et al., 2008),
- affective organisational commitment (Hewlett & Luce, 2005),
- interesting and stimulating work (Harden, Boakye, & Ryan, 2018),
- accountable work cultures (SWE, 2016),
- organisational fairness, training and development, and opportunities for advancement (Fouad et al., 2017).

Barriers to engineering persistence include:

- poor organisational socialisation, onboarding or inductions, and disagreeable workplace relationships (Korte et al., 2019),
- Inflexible and demanding work, poor workplace climate, a lack of work role clarity, inequitable working conditions, perceived dissatisfaction, and lack of compensation (Fouad et al., 2017),
- intermittent work, a lack of recognition and limited technical career pathways (Australian Workforce and Productivity Agency, 2014).

## Theoretical perspectives of career pathways

An individual's complex career choices can be investigated through career development theories, an accepted approach utilised in other published research into engineers' career pathways (Fouad et al., 2020; Winters, 2012). The Theory of Work Adjustment (TWA) describes an individual's relationship with their work environment, positing that career choices and development are continuing processes of adjustment. An individual's occupational values comprise achievement (accomplishment), altruism (service), autonomy (initiative), comfort (non-stressful), safety (predictable), and status (prestige). Flexibility, reactivity and perseverance are types of adjustment between the employee and employer. Adjustment can lead to satisfactoriness (determined by the employer) and satisfaction (determined by the employee) (Dawis, 2004). TWA has been utilised by previous researchers to investigate engineering occupational outcomes, concluding that these outcomes differ by gender. Both genders report leaving the profession due to achievement needs (loss of interest in the field, or not liking allocated tasks) and status needs (lack of advancement opportunities). However, men are also likely to leave due to additional status needs (seeking a higher salary), whereas women are more likely to leave the engineering profession due to comfort needs (seeking more family time) (Fouad et al., 2017).

Organisational socialisation defines how commencing employees understand and integrate into their new role (Korte et al., 2019). Adequate socialisation of early career engineers leads to a sense of belonging and commitment (Lutz & Paretti, 2021), whereas those without a sense of belonging or value in their organisation are more likely to leave (Beddoes, 2021). This affective organisational commitment is linked directly to a reduction in turnover intentions (Harden et al., 2018). Organisational supports include company policies, graduate programs, and support from management, co-workers, and mentors (Baruch & Rousseau, 2019). Psychological contracts, the promises, expectations and obligations made between employee and employer are influenced by organisational commitment, personal goals, and career planning. Previous research identified that career commitment, engagement, and satisfaction of Australian women engineers can lead to engineering persistence (Ayre et al., 2013; Fouad, Singh, Cappaert, Chang, & Wan, 2016).

Career optimism is "a disposition to expect the best possible outcome or to emphasise the most positive aspects of one's future career development" (Rottinghaus, Day, & Borgen, 2005, p. 11). Career optimistic individuals have a higher tendency to be interested in their future careers, engage in learning directed toward that future, and believe in their potential career success. Job performance and career satisfaction have been positively linked to career optimism and positive expectations (Eva, Newman, Jiang, & Brouwer, 2019).

## Theoretical model development

Our study intends to collate and build upon previous research of a civil engineer's career optimism by creating an integrated model. This sequential mixed methods research is grounded in social constructivism. Our exploratory and explanatory inductive research design allows analysis of the complex data related to an individual's subjective reporting of their experiences (Creswell, 2014). Our Concept Model is guided by literature about engineering practice and persistence, and informed by the theories of Work Adjustment, Organisational Socialisation, Psychological Contracts, and Organisational Commitment. Our model is constructed upon the *Person* (Individual's abilities and skills; Influences; and Values), the *Environment* (Organisational Support), and the *Adjustment* between them. Our concept model is presented in Figure 1 below with the constructs expanded in previous publications (Reis et al., 2020, 2021).

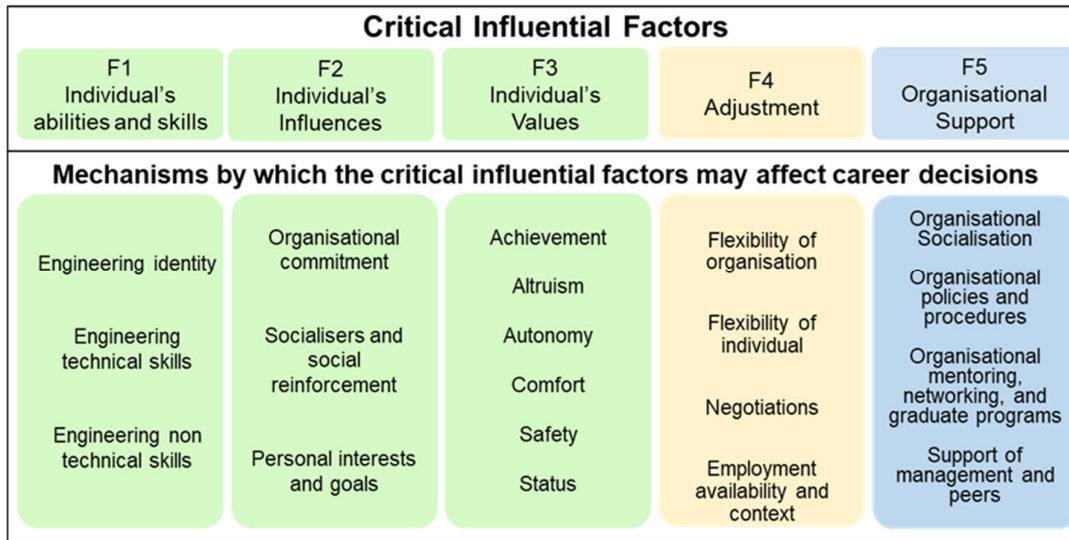


Figure 1: Our Early Career Civil Engineer's Trajectory Concept Model

## Questionnaire development and refinement

Our CTS Questionnaire (the Survey) development was guided by the relevant literature on engineering practice and persistence (described above), our concept model (Reis et al., 2020), survey theory (Neuman, 2014), scale development and validation theories (Boateng, Neilands, Frongillo, Melgar-Quiñonez, & Young, 2018), and our Pilot Survey (Reis et al., 2021). We have adapted items from instruments including the Organisational Commitment Scale (Meyer, Allen, & Smith, 1993), APPLES (Sheppard, Antonio, Brunhaver, & Gilmartin, 2015), PEARS (Brunhaver et al., 2015), EPS (Winters & Matusovich, 2015), Workplace Transitions (Huff, Smith, Jesiek, Zoltowski, & Oakes, 2019) and Organisational Socialisation (Korte et al., 2019). The questionnaire has 28 items, including 9 demographic questions, 12 rating (Likert) questions, 5 open ended questions, and 11 closed or partially closed questions.

## Participants

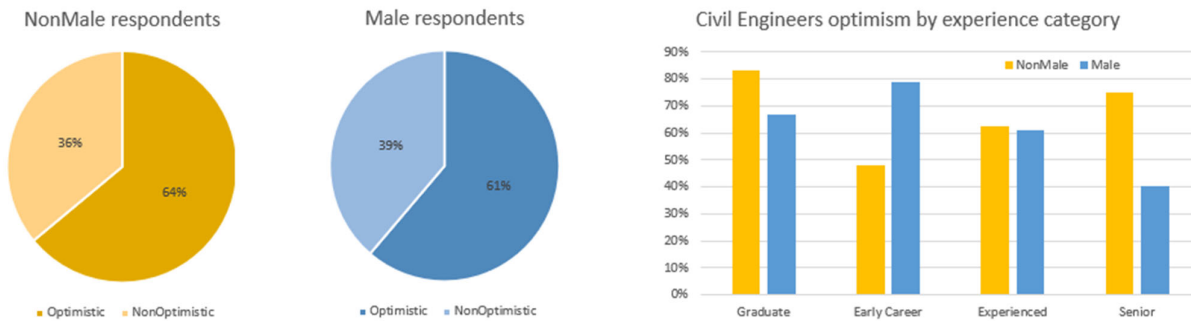
Our survey deployment plan, including recruitment strategies, coverage and sampling checks is described in our previous publication (Reis et al., 2021). Our nationwide survey participants included 235 professional civil engineers, with an experience range of 60 years and a median of eight years of experience after Bachelor's degree graduation. To enable comprehensive analysis, the ordinal variable Experience Category was created by collapsing Years Experience into four categories; Graduate n57 24.3% (0-3 years), Early Career n63 26.8% (4-8 years), Experienced n65 27.7% (9-20 years), and senior n50 21.3% (>20 years).

To allow comparison by gender, we compared the male gender, dominant in the engineering profession, with other genders. Thus, the independent variable of gender was collapsed into two categories, male and nonmale. Of the 31.9% nonmale respondents, all but two identified as female. Compared to the 11.2% industry average (Engineers Australia, 2019), this high response rate can provide more robust data for examining the experiences and challenges of minorities (Neuman, 2014). Regarding education, 75% (n176) had attained only a bachelor's degree, with 23% (n54) holding additional post graduate qualifications. Participant's industry categories were comparable with industry averages and include Construction and Operations (19%); Professional, Technical and Management Consulting (46%); and Education, Training and Research (14%). The majority of respondents (70.2%) work for large organisations (Reis et al., 2021).

## Analysis and Results

To answer our research questions, the data was analysed to determine if outcomes differ between demographic groups. We utilised nonparametric descriptive statistics including Pearson's chi-square test for independence to determine relationships (Hair, Black, Babin, & Anderson, 2014). To further our understanding of career optimism we utilised the demographic and independent variables to analyse the binomial dependent variable *looking forward: I am optimistic about a future in engineering*. Of the 235 civil engineers, 62% are optimistic about a future in engineering (optimistic). Career optimism varies significantly when contrasted by gender and experience, refer to Figure 2, with only 61% of Males reporting optimism compared to 64% of Nonmales. By experience category, graduates expressed the highest optimism (71.9%), with a continuing decrease to senior engineers (46.9%) ( $\chi^2(3, n235) 8.4, p.038$ ). Considering Nonmales, early career nonmales report the lowest optimism (48%) and graduate nonmales the highest (83.3%). Considering Male respondents, the highest optimism was reported by early career engineers (78.9%) and the lowest by senior engineers (40.5%) ( $\chi^2(3, n160) 13.1, p.004$ ).

Responses to the items regarding organisational size, industry sector or geographic location did not differ significantly by experience or gender.



**Figure 2: Optimism by demographic group**

To further explore an individual's career optimism, we identify the items that are rated 4 or 5 on a 5-point Likert scale by more than 80% of optimistic civil engineers, as presented in Table 1. Additionally, in this table, we contrast respondents' demographics against the independent variables

The items rated highest by optimistic civil engineers are the *enjoyment of work and environment* (94%), *collaboration, teamwork and communication* (92%), and *practical engineering problem solving skills* (91%). Other highly rated items include *self management and professionalism* (88%), and the *need for relationships* within the work environment (88%).

**Table 1: Independent variables rated highest by optimistic civil engineers (n146)**

Question	Response Item	Rating <sup>(a)</sup>	Highlighted Demographic Test (Pearson's chi-square test)
To me, the essence of engineering is <sup>(1)</sup>	Creative solutions	82%	No statistical difference when comparing genders or experience levels
	Helping others	82%	
Which technical engineering abilities and skills are most important in your current role? <sup>(1)</sup>	Practical engineering problem solving skills	91%	Those with postgraduate qualifications rated practical skills lower ( $\chi^2 (1, n146) 4.58, p.032$ )
Which professional engineering abilities and skills are most important in your current role? <sup>(1)</sup>	Collaboration, teamwork and communication	92%	Those with postgraduate qualifications rated collaboration lower ( $\chi^2 (1, n146) 11.7, p.001$ )
	Self-Management and professionalism	88%	
Could you tell us more about your current role? <sup>(2)</sup>	I enjoy my current work and working environment	94%	Older engineers rated belonging higher than younger engineers <sup>(b)</sup> ( $\chi^2 (1, n146) 5.81, p.016$ )
	I feel a sense of belonging to this organisation	86%	
How highly do you value a professional role that: <sup>(3)</sup>	Provides a variety in work	87%	Those with postgraduate qualifications rated organisational support and job security lower ( $\chi^2 (1, n146) 4.45, p.033$ ) ( $\chi^2 (1, n146) 11.1, p.001$ )
	Provides support from the organisation and my team	86%	
	Provides me with job security	83%	
	Provides me with responsibility	86%	
Can you rate the following items regarding your needs within a work environment? <sup>(3)</sup>	Building relationships within my team and stakeholders	88%	Younger engineers rated the need for fair work, advancement and remuneration higher than older engineers <sup>(b)</sup> ( $\chi^2 (1, n146) 5.5, p.019$ ) ( $\chi^2 (1, n146) 5.42, p.020$ ) ( $\chi^2 (1, n146) 12.5, p<.001$ )
	Fair working conditions and work-life balance	86%	
	Opportunities for advancement and recognition	84%	
	Provision of fair remuneration	82%	
	Accomplishment and utilisation of abilities	84%	
How important are the supports provided by your organisation? <sup>(5)</sup>	Co-worker relationships	83%	Nonmales rated their manager's support higher than males did ( $\chi^2 (1, n146) 4.90, p.027$ )
	Management & supervisor support	82%	

(a) Percentage of optimistic respondents rating the item as very important or extremely important, agree or strongly agree (4 or 5 on a 5-point Likert scale)

(b) Participants were also categorised binomially by experience level, as a Younger (0-8 years of experience) or Older (>8 years of experience) cohort.

(1-5) Factor numbers from the Concept Model

## Discussion

In this article, we present preliminary findings from our Early Career Civil Engineer Trajectory Study, identifying the items rated the highest by optimistic civil engineers and highlighting differences for demographic groups.

Interestingly, the optimism reported by nonmale graduates was higher than for male graduates. Compared to males, female engineering graduates spent less time finding their first engineering position for the same salary; this may be due to the gender equality initiatives of the Workplace Gender Equality Act and may lead to their increased optimism (Australian Government, 2022; Osten, 2021). Career optimism then reduced sharply for nonmales moving from the graduate to the early career category. In contrast, early career males reported higher optimism than other males. The significantly lower career optimism of early career nonmales compared to males ( $\chi^2(1,n63) 6.50, p.011$ ) requires further investigation.

Optimistic civil engineers highly rated enjoyment of their work and working environment, with older engineers rating this significantly higher than younger engineers. This affective organisational

commitment is strongly linked to occupational commitment, highlighting the importance of this construct. Thus, we confirm the results of a previous study that female engineering persisters report higher levels of workplace support and occupational commitment (Fouad et al., 2016).

The professional engineering abilities and skills of *collaboration, teamwork and communication, self management and professionalism*, as well as the technical engineering abilities and skills of *practical engineering problem solving skills* highlight the socio-technical nature of engineering. This is a dualism that many engineers straddle as part of their *engineering identity* (Morelock, 2017), highlighting the need to consider these constructs jointly rather than separately.

The highest rated occupational need within a working environment was *building relationships within the team and stakeholders* (altruism need). This outcome is of particular interest as, to our knowledge, this is the first study identifying the occupational need for altruism as an occupational need for practicing engineers. Further investigating occupational needs, younger engineers rated the need for fair work (comfort), advancement (status) and remuneration (safety) significantly higher than did older engineers. This may be due to the occupational embeddedness exhibited by individuals during their later career stages (Feldman & Ng, 2007), which we continue to explore.

Of the items rated highest by optimistic civil engineers, the only item to significantly differ by gender is the importance of manager and supervisor support. This item is rated significantly higher by nonmales than by males. Previous studies identifying the importance of workplace support (Fouad et al., 2016) and mentoring (Brunhaver et al., 2015; Korte et al., 2019) to the continuing persistence of female engineers have specifically focused on the support of managers and supervisors.

The impact of a post graduate qualification on a civil engineer's career optimism requires further investigation. These respondents reported significantly lower optimism and a lower need for organisational support and job security. This result raises significant questions for our profession. To the engineering profession, what is the value of a higher degree in engineering if it leads to the recipient leaving the profession?

## Conclusion

Our study offers valuable new insights into the career optimism of a wide demographic of Australian civil engineers. Career optimism is linked to job performance, satisfaction, and work happiness, but differs by gender and years of professional experience. Optimistic civil engineers report a dualist engineering identity, the importance of affective commitment and the occupational need for altruism. Results from our research can be used by engineering associations and organisations as a strong conceptual basis for designing interventions to strengthen a civil engineer's career optimism.

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