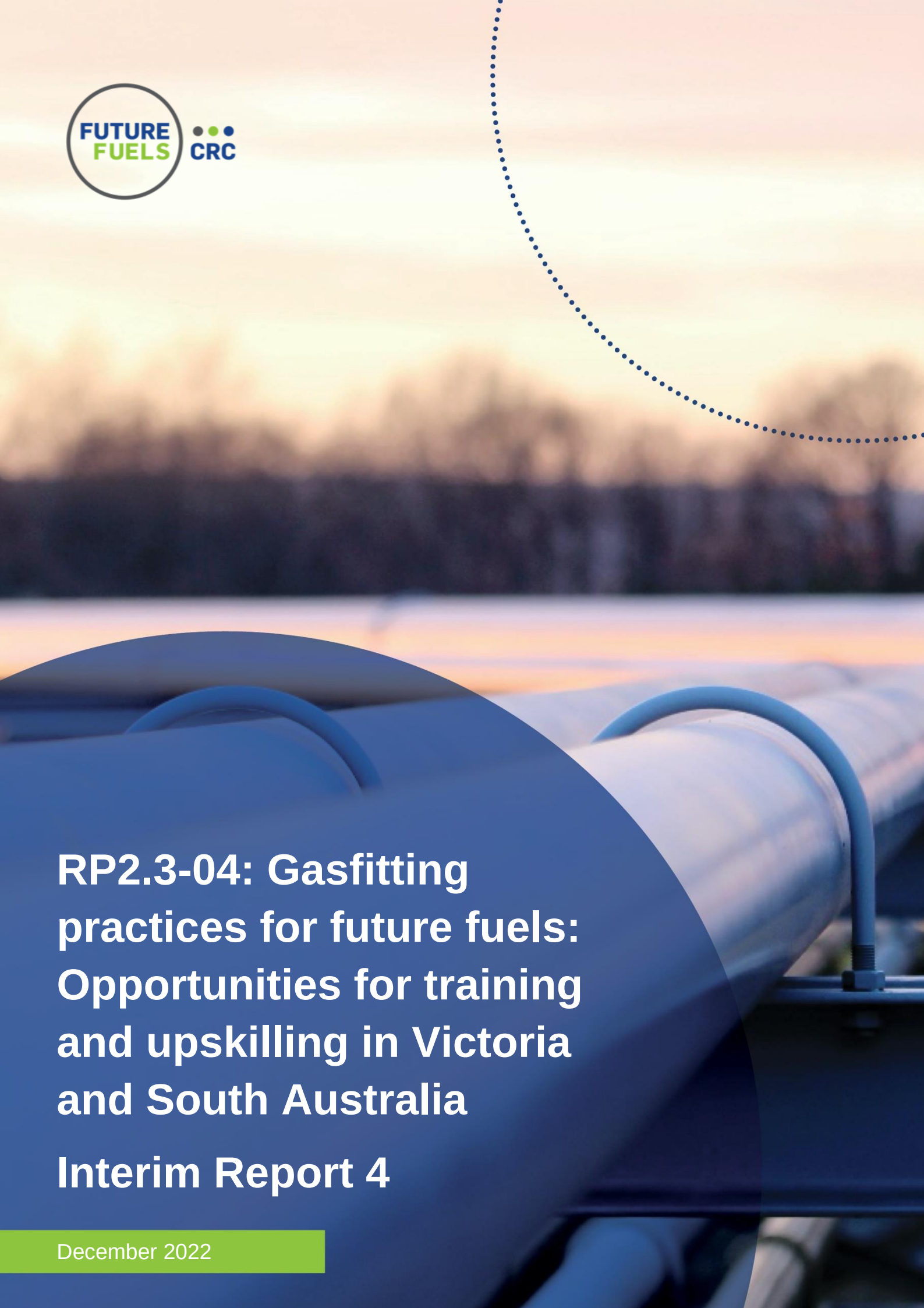


RP2.3-04: Gasfitting practices for future fuels: Opportunities for training and upskilling in Victoria and South Australia

Interim Report 4

December 2022

Project number: RP2.3-04

Gasfitting practices for future fuels: Opportunities for training and upskilling in Victoria and South Australia

Authors:

Dr Orana Sandri (RMIT)

Associate Professor Sarah Holdsworth (RMIT)

Professor Peter Wong (RMIT)

Professor Jan Hayes (RMIT)

Professor Ron Wakefield (RMIT)

Project team:

Paul Harris (ESV)
Ross Jamieson (GAMAA)
Lynette Day (DEM)
Peter Daly (Master Plumbers)
Nazra Hameed (VBA)
Paul Beaumont (RSHQ)
Andrew Clarke (Master Plumbers SA)
Tobias Terry (CBOS)

Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program

This work is funded by the Future Fuels CRC, supported through the Australian Government's Cooperative Research Centres Program. We gratefully acknowledge the cash and in-kind support from all our research, government and industry participants.

Important Disclaimer

Future Fuels CRC advises that the information contained in this report comprises statements based on research. Future Fuels CRC makes no warranty, express or implied, for the accuracy, completeness or usefulness of such information or represents that its use would not infringe privately owned rights, including any parties' intellectual property rights. To the extent permitted by law, Future Fuels CRC (including its employees and Participants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this report (in part or in whole) and any information or material contained in it.

Acknowledgement

This work is funded by the Future Fuels CRC, supported through the Australian Government's Cooperative Research Centres Program. The cash and in-kind support from the industry participants is gratefully acknowledged.

The authors would like to acknowledge the insight and advice provided by the Industry Advisory Group and the time and knowledge generously volunteered by our research participants.

Project Information

Project number	RP2.3-04
Project title	Gasfitting practices for future fuels: Opportunities for training and upskilling in Victoria and South Australia
Research Program	Research Program 2 – Social Acceptance, Public Safety and Security of Supply
Milestone Report Number	Interim Report 4
Description	Practical delivery of future fuels to the public requires that appropriate trade resources (i.e. gasfitters) are available. This project assesses the current state of the gasfitting trade in terms of numbers, registration and continuing professional development, identifies the evolving knowledge base to develop the necessary skills for future fuels and assesses the capacity of the existing training, certification, registration and reregistration of gasfitters in Victoria and South Australia to deliver the necessary workforce capabilities and capacity for a successful transition and ongoing sustainability of a future fuel economy.
Research Provider	RMIT University
Project Leader and Team	Jan Hayes, Sarah Holdsworth, Orana Sandri, Ron Wakefield, Peter Wong (RMIT)
Industry Proponent and Advisor Team	Paul Harris (ESV), Ross Jamieson (GAMAA), Lynette Day (DEM), Peter Daly (Master Plumbers), Nazra Hameed (VBA), Paul Beaumont (RSHQ), Andrew Clarke (Master Plumbers SA), Tobias Terry (CBOS).
Related Commonwealth Schedule	This work is part of Output 2.3. It does not relate to a specific milestone.
Project start/completion date	Nov 2020/ Nov 2022
IP Access	**Open – available publicly to all parties outside the CRC**
Approved by	Paul Harris
Date of approval	5/12/2022

Table of Contents

Summary of Report

This report presents the findings from a national survey of plumber/gasfitters that aimed to better understand their attitudes toward training practices, the sources of information/learning in their day-to-day practice and their awareness of hydrogen and preferences for upskilling. As reported in Interim Reports 1 and 2, interviews undertaken with 40 gasfitters in Victoria and South Australia identified that gasfitters from this sample broadly supported the use of hydrogen as a future fuel and were willing to undertake additional training for hydrogen as needed, provided it was relevant and accessible. The interviews also provided insights into a range of learning and training practices that are undertaken and valued by interview participants. Given the absence of existing research on gasfitters or plumbers, these interviews provide a first step in understanding the learning contexts and preferences of gasfitters in the two case study states. The broad objectives of the national survey described in this report were to:

- Determine the relevance of themes identified in the interview data (reported in Interim Reports 1 and 2) in the broader population of interest.
- Achieve both breadth and depth of data when combined with the qualitative interview data.
- Capture views in additional states around Australia that were not captured in Interim Reports 1 and 2 which focused on Victoria and South Australia.

The survey specifically aimed to answer the following research questions:

- What are plumber/gasfitters' attitudes towards training now and towards future training for hydrogen?
- What groups and people are influential in plumber/gasfitters' training practices now and in future training for hydrogen?
- What are the barriers and enablers for plumber/gasfitters to undertake training?
- What are plumber/gasfitter preferences for training for hydrogen?

The Theory of Planned Behaviour (TPB) was used to inform the survey design. TPB is a validated framework to understand what motivates certain behaviours, such as undertaking training, in order to design interventions to change or further support desired behaviours. In TPB, the intention to perform a behaviour (to do something) is influenced by three antecedents that include a person's beliefs and attitudes towards a particular behaviour, their subjective norms, or in other words, their beliefs that important people or groups will approve of and support their behaviour, and thirdly, their perceived behavioural controls, e.g. time, money, access to training. In the TPB framework, if these 'behavioural antecedents' support a behaviour, in this case training, then the individual will likely carry out that behaviour. The survey also collected basic demographic data as well as data on awareness of hydrogen properties and plans for hydrogen as a future fuel in Australia.

The national survey was distributed by regulators and industry associations via email and also in some seminars. The survey was open for responses for approximately 3 months between May and September, 2022. A total of 1001 surveys were completed by plumbers and gasfitters across Australia, with a response rate of 1.27%. Comparison of response means, one-way Anova and structural equation modelling was used to analyse the data and build models of plumber/gasfitters' behavioural intention to undertake training now and in the future with hydrogen, including the relationships between training intention and the antecedents of behaviour.

The results showed that plumber/gasfitters' intention to undertake training is driven by their attitudes towards training and associated perceived benefits of training, but not substantially by their perceived subjective norms or behavioural controls. This suggests that plumber/gasfitters are independently interested in undertaking training because of a variety of benefits this provides, in particular, developing their skills and knowledge for their gasfitting practice and using their skills and knowledge to undertake safe work that protects their customers. The results also showed that plumber/gasfitters surveyed have undertaken some form of training between 3 to 6 times in the past three years. Respondents also expressed a strong positive attitude towards future hydrogen training however they currently have limited awareness of hydrogen and associated industry plans.

In the context of future hydrogen training, there is an opportunity to benefit from plumber/gasfitters' strong positive attitudes towards such training by providing further information about the benefits of training and the transition and ensure that the variety of influential stakeholders that shape practice and ongoing learning are well informed about hydrogen plans and associated implications for gasfitting and training options. Such training options must be easily accessible and affordable for gasfitters in both regional and metropolitan areas.

To maximise uptake of training, it is essential that training programs for gas fitters generally:

- Communicate and include content regarding the value of training, particularly the development of skills and knowledge enabling safe work practices and customer safety;
- Ensure key influential stakeholders and information/learning sources such as suppliers/manufacturers, insurers and regulators are aware of and on board with the development of any training to be undertaken; and,
- Are easily accessible at an affordable price to gasfitters.

In addition to these considerations, with regards specifically to maximising the uptake of hydrogen training, programs should:

- Be accompanied by communication that highlights the relationship between hydrogen and the long-term viability of the gasfitting trade to take advantage of the positive attitudes towards hydrogen training;
- Involve regulators and industry associations in the design and delivery of hydrogen training programs to ensure these key influential stakeholders show their support for training, even if training is delivered by TAFEs and other registered training organisations;
- Provide face-to-face hydrogen training opportunities; and,
- Be foreshadowed by a communication campaign that increases awareness about the transition to hydrogen as a future fuel to all key stakeholder groups.

1. Introduction

Significant changes are facing Australia's domestic energy sector however much of the planning to date has focused on technology requirements. In order to successfully transition to a new energy future, skilled trades practitioners are essential (AIS, 2019). While hydrogen as a future fuel will require skilled professionals and practitioners across the hydrogen supply chain, the potential use of hydrogen as a future fuel in Australian households means that gasfitters working downstream of the meter on household gas and appliance installations, servicing and maintenance and conversion, are an essential trade as part of the transition to hydrogen. Gasfitters are also seen as a trusted source of information for consumers and play a key role in consumer uptake of new technology. Given the potential disruption of well-established work practices, a planned response to future fuel transition is needed that considers the new and evolving knowledge base, associated competencies, and resourcing levels required to support hydrogen in gasfitting work. This not only applies to emerging tradespeople but also registered gasfitters currently practising, training apprentices and advising customers. Consequently, it is essential to, firstly, determine the capacity of the existing gasfitter workforce to meet the increased workload generated by transition to a hydrogen fuel economy, and secondly, ascertain how to best manage the change process to train and upskill gasfitters to develop the required competencies to work with hydrogen. This research project, therefore, aims to understand:

- the skills requirements for Type A gasfitting for hydrogen;
- the capacity of existing training structures to support the development of hydrogen competencies;
- the capacity of existing gasfitters to upskill;
- the amount of work the change will generate and the ability of the existing gasfitter (after upskilling) to complete this work;
- the need to train additional plumbers as gasfitters; and,
- the support mechanisms in place to help the industry address the new work environment as the transition occurs.

To address these questions, this research has so far investigated the status and structure of gasfitter training in Victoria and South Australia, including the current systems for training and ongoing learning for gasfitters, and the resourcing level and evolving knowledge base required for gasfitting for future fuels. A desktop review of relevant literature and regulation has been undertaken, complemented by interviews with key stakeholders including training, industry and government organisations, and gasfitters themselves in Victoria and South Australia. These findings are available in Interim Reports 1 and 2. Interim Report 3 presented the results of a desktop review of ten training regimes in occupations other than gasfitting to develop an understanding of how to train, upskill and support gasfitters in a fuel transition. This knowledge is important as, while there is literature that describes reskilling approaches for whole industries and regions in low carbon transitions, for example from coal fired electricity to renewable energy (for example see Gambhir, Green, & Pearson, 2018), there is minimal literature describing the best ways to upskill members of existing occupations as a result of emerging practices and technologies. Upskilling involves the attainment of additional skills and/or knowledge to work with new technologies or practices in one's existing occupation. In other words, upskilling 'is an increase in skill level resulting from technical change or job redesign and the associated training' (Heery & Noon, 2017).

Furthermore, the research on professional development within different industries focusses on professional development within large organisations rather than smaller businesses engaged in self-employed or sub-contracting, reflective of the construction industry. Professional development is a process of maintaining and enhancing professional knowledge and skills, post initial qualification. While the term 'professional' implies development programs for professional roles, the term is applied more broadly to non-professional occupations such as trades. Generally, professional development refers to some formal and discrete training experience designed to maintain or enhance a professional's (and in this context practitioner's) work practices (Webster-Wright, 2009). This report refers to professional development as 'ongoing learning' as this broader term includes practitioners and a range of informal and formal learning activities. Almost all gasfitters are self-employed and/or work as part of a small business (50 per cent sole traders/partnerships, 48.6 per cent less than 20 employees) (Kelly, 2020) and are responsible for their own ongoing learning to maintain their 'industry currency' to perform work to standard. Responsibility for ongoing skill development is also the case also for those who undertake subcontracting roles in the construction industry. As such, limited research exists on how to ensure sole traders and small businesses engage in meaningful training and learning activities for upskilling and the best approaches to regulate such activity.

This report, presents the findings from a national survey of plumber/gasfitters to better understand their attitudes toward training practices, the sources of information/learning in their day-to-day practice and their awareness of hydrogen and preferences for upskilling. The report commences with a description of the method and theoretical framework used in the survey design in Section 2 followed by the survey results in Section 3. Section **Error! Reference source not found.** then summarises these results and highlights their implications for training and upskilling gasfitters to work with hydrogen, followed by implications for industry in Section 0 and the next steps in this research project in Section 6.

2. Research methodology

2.1 The survey

For this research phase, a survey was undertaken of plumbers/gasfitters in Australia. As reported in Interim Reports 1 and 2, interviews undertaken with 40 gasfitters in Victoria and South Australia identified that gasfitters from this sample broadly supported the use of hydrogen as a future fuel and were willing to undertake additional training for hydrogen as needed, provided it was relevant and accessible. The interviews also provided insights into a range of learning and training practices that are experienced and valued by interview participants. Given the absence of existing research on gasfitters or plumbers, these interviews provide a first step in understanding the learning contexts and preferences of gasfitters in the two case study states. The broad objectives of the national survey reported here were to:

- Determine the relevance of themes identified in the interview data (reported in Interim Reports 1 and 2) in the broader population of interest.
- Achieve both breadth and depth of data when combined with the qualitative interview data.
- Capture views in additional states around Australia that were not captured in Interim Reports 1 and 2 which focused on Victoria and South Australia.

The survey specifically aimed to answer the following research questions:

- What are plumber/gasfitters' attitudes towards training now and towards future training for hydrogen?
- What groups and people are influential in plumber/gasfitters' training practices now and in future training for hydrogen?
- What are the barriers and enablers for plumber/gasfitters to undertake training?
- What are plumber/gasfitter preferences for training for hydrogen?

The survey questions were designed based on the Theory of Planned Behaviour explained in the following section.

2.1.1 Theory of Planned Behaviour

Theory of Planned Behaviour (TPB), developed by Icek Ajzen in the 1980s, is an internationally accepted model for understanding human behaviour, and has been applied across a range of domains including advertising and consumer behaviour (Jalilvand & Samiei, 2012), health (Gu et al., 2019; Hagger & Chatzisarantis, 2009; Van der Merwe & Kagee, 2006), sustainability (Blok, Wesselink, Studynka, & Kemp, 2015; Judge, Warren-Myers, & Paladino, 2019; Si, Shi, Tang, Wu, & Lan, 2020) and education (Archer, Elder, Hustedde, Milam, & Joyce, 2008; Ates, 2019). TPB is a framework to understand what motivates certain behaviours in order to design interventions to change or further support behaviours (Ajzen, 1991). In TPB, motivation is based on a person's beliefs about a behaviour, social/subjective norms, and behavioural controls. These are the antecedents for behaviour. The theory begins with the *behavioural intention*, that is, if an individual intends to undertake a behaviour and other factors are supportive of that behaviour, then that individual will likely undertake the behaviour. To understand behavioural intention, three key *behavioural antecedents* must be determined including a person's:

- *Perceptions/beliefs towards the behaviour* (positive or negative views, beliefs about outcomes)
- *Perceptions/beliefs about the social (subjective) norms* regarding the behaviour (what others think I should do and what others are doing)
- *Perceptions/beliefs about controls on behaviour* (time, money, skills, self-efficacy) (Ajzen, 1991).

In addition, people's *actual behaviour* must also be understood (do they perform the behaviour now) and their *prior experience* of the behaviour if they have performed it before. Beyond perceptions about controls on behaviour, there are *actual controls on behaviour* (structural barriers), however perceptions of controls can act as a proxy for actual controls (Ajzen, 2016). Figure 1 shows Ajzen's TPB model showing the relationships between behaviour, intention and the three antecedents of intention.

Figure 1 Theory of Planned Behaviour (TPB)

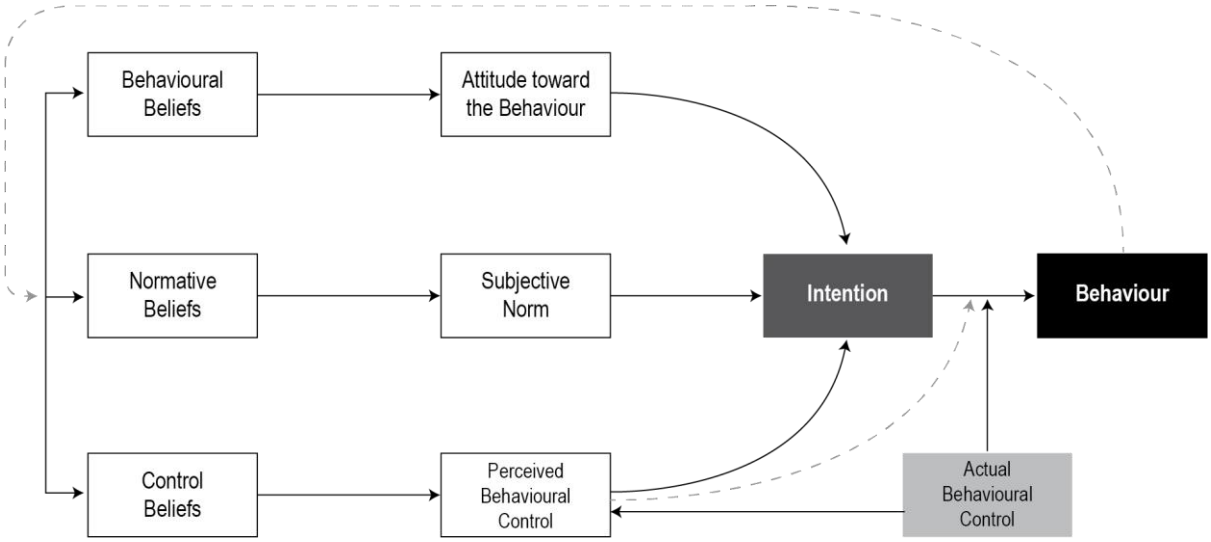


Figure recreated from Ajzen (2016)

TPB can be used for motivating people to engage in a behaviour by promoting strong, positive intentions towards the behaviour; address obstacles to the performance of the behaviour, and; evaluate the success or failure of an intervention by understanding how an intervention has influenced the behavioural antecedents (Ajzen, 2016).

In the context of gasfitting training/upskilling, TPB has been used in this survey to understand what gasfitters *likely behavioural intention will be/is* towards ongoing training and understand how they can be motivated or further incentivised to upskill for hydrogen. TPB can help us understand what are the *factors that inform gasfitters training/upskilling behaviour* and what would motivate them to upskill. This can then inform a *broader change strategy for incentivising* the uptake of training to comply (or assist in compliance) with standards and regulations. In the case of plumber/gasfitters ongoing training/upskilling for hydrogen, TPB was chosen as the research method as it can help understand:

- How industry and government can motivate plumbers/gasfitters to undertake ongoing training/upskilling
- How industry and government can promote positive intentions towards ongoing training
- How industry and government can help remove existing barriers
- How the system is currently working in terms of motivating plumbers/gasfitters to undertake further training/upskilling

Figure 2 shows the TPB model applied to the context of plumber/gasfitters' ongoing training/upskilling for hydrogen.

Figure 2 TPB applied to plumber/gasfitters ongoing training/upskilling for hydrogen

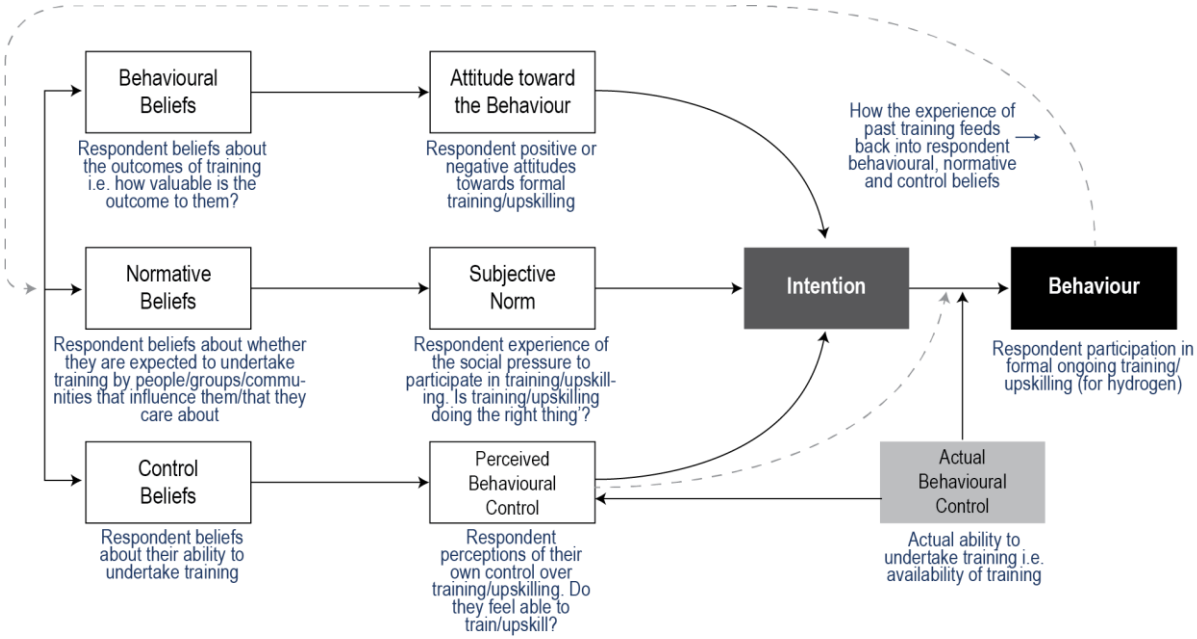


Figure adapted from Ajzen (2016)

2.1.2 Survey design

A survey tool is a useful way to collect data on the components or 'constructs' within the TPB model shown in Figure 1 and Figure 2 for a population of interest. Within a survey and the subsequent data analysis, behavioural antecedents above, that is, behavioural attitudes, subjective norms and behavioural controls are referred to as 'latent variables' or 'constructs' as they are abstract concepts and cannot be directly measured in a survey. Instead, data must be collected for indicators, or in other words, observed variables for these behavioural antecedents. Data on observed variables is collected in a series of operational statements/question items that are used to indicate or infer relationships to the latent variable/construct. A survey tool allows for the collection of multiple indicators of a latent variable/construct. In this case, we present a series of operational statements regarding respondents' beliefs, perceived social expectations and perceived behavioural controls to measure the latent variables, i.e. their attitudes, subjective norms and behavioural controls. Within the model in Figure 1 and Figure 2, intention to behave can be asked directly in a survey question, as well as actual behaviour, and therefore these are also observable variables.

The survey was structured to firstly collect demographic information of respondents. The second section of the survey asked a series of questions to measure the influence of different attitudinal, subjective norm and behavioural control variables on current training behaviour. Operational statements asked respondents about their beliefs about the benefits of training, those influential on their training practice and factors that enable or prevent them from participating in training. This section aimed to provide a baseline of influences shaping existing training practices. The third section of the survey asked a similar set of questions as in Section 2, however, these questions focused on upskilling for hydrogen. This section first began with questions about respondent's level of knowledge about hydrogen and Australian plans for a future hydrogen industry, followed by the questions related to the TPB framework. Most questions in Section 1 and 2, used Likert Scales to measure levels of agreement with operational statements and associated variables (i.e. strongly agree to disagree) and one question measured frequency (i.e. never to very often). The survey also asked about respondents' training preferences for hydrogen and provided a qualitative comment box to provide any further comments about the survey, training and hydrogen. See Appendix 7.2 for a full list of the survey questions, their purpose and answer options.

A critical component of a TPB questionnaire is the elicitation of salient beliefs, subjective norms and behavioural controls that form the variables or operational statements/question items in the survey. This research used the previous interviews with 40 gasfitters to elicit the salient beliefs, subjective norms and behavioural controls for the

sample population, supplemented by literature on small business learning. This step in the survey design ensures that operational statements reflect the survey population (Ajzen, 1985). In addition, interview data supplemented by a desktop review of different training options available in Australia was used to develop the list of potential training options for hydrogen to measure respondent preferences. These salient beliefs, norms, behavioural controls and training options are shown in Appendix 7.1. The survey was piloted and reviewed by the eight member industry advisory group and their associates before it was distributed.

2.1.3 Survey distribution, sample and response rates

The target respondents for this survey included plumbers and gasfitters across Australia. A link to the survey was distributed via plumbing/gasfitting regulators in each state and territory in Australia (except Northern Territory) via email and in industry workshops. As gasfitting is a licensed trade in all Australian jurisdictions, distribution via the regulators ensured that all licensed/registered plumber/gasfitters with current email addresses were invited to complete the survey. In addition, the survey was also distributed via the plumbing association Master Plumbers in Victoria and Australian Capitol Territory. The survey was not directly distributed to plumber/gasfitters in Northern Territory as this is the only jurisdiction in Australia with no gas distribution network and hydrogen supplied to homes via a mains network will likely not occur in the Northern Territory. The survey was open for responses for approximately 3 months from the 27th of May, 2022 to the 2nd of September, 2022. Reminder emails were sent by the regulators in the states of Queensland and Victoria. A total of 1001 surveys were completed by plumbers and gasfitters across Australia. According to the most recent labour force data from the ABS, there were 79,900 people working as plumbers in Australia in 2021, with 600 of those located in the Northern Territory (ABS, 2022). It is assumed all registered/licensed plumbers were contacted in all states and the Australian Capitol Territory, therefore approximately 78,400 plumber/gasfitters were invited to complete the survey via email and in industry workshops. As the samples were collected from plumbing/gasfitting regulators and associations which are the official bodies that regulate and represent the industry, views collected from this survey are believed to be reflective of the industry views. 1001 surveys were received, equivalent to a response rate of 1.27%.

2.2 Data analysis

Data analysis firstly involved comparing the means of responses regarding practices, attitudes, subjective norms, behavioural controls, awareness of hydrogen and training preferences. A one-way ANOVA using Statistical Package for Social Sciences (SPSS) Version 28.0 was then performed to determine if there were significant differences between respondent demographic groups and the above variables. Following this, a two-step analysis approach, recommended by Jöreskog and Sörbom (1996), was employed to examine the relationships between the TPB behavioural antecedents (respondents' attitudes, subjective norms and behavioural controls) and existing training behaviour and future hydrogen training behaviour. In doing so, two separate models were developed, one for current training behaviour and one for future hydrogen training behaviour. The two-step approach involved firstly checking construct reliabilities and inter-relationships within the model and secondly, performing structural equation modelling (SEM) to test the relationship framework. These two steps are further explained in what follows.

2.2.1 Step 1: Checking construct reliabilities and inter-relationships

Firstly, the internal consistency of the constructs was checked to ensure the appropriateness of groupings of the latent variables (attitudes, subjective norms and behavioural controls) and their associated observed variables. The validation was done by conducting a Cronbach's alpha reliability test which produces an alpha value ranging from 0 to 1. The higher the alpha value, the greater the internal consistency of the construct. A Cronbach's alpha value greater than 0.7 indicates that the latent variables are significantly related to the associated observed variables and that the internal consistency of the construct is 'good' (Hair, Anderson, Tatham, & Black, 1998). Pearson Correlation analysis was used to check the construct inter-relationships to validate the proposed inter-relationships among constructs within the framework. Statistical Package for Social Sciences (SPSS) - Version 28.0 was used to complete the Cronbach's alpha reliability testing and Pearson correlation analysis.

2.2.2 Step 2: Structural Equation Modelling

The second step involves testing the fitness of the relationships between latent and observable variables within the model using structural equation modelling (SEM) (Jöreskog & Sörbom, 1996). SEM integrates both multiple regression analysis (MRA) and confirmatory factor analysis (Molenaar, Washington, & Diekmann, 2000; P. Wong, Cheung, & Fan, 2009) and can be used as part of theory development, allowing the testing of propositions

about the relationships amongst variables in a multivariate context (Cheung, Wong, & Lam, 2012; Hair et al., 1998). The advantage of SEM is that it is a multivariate technique (Hair et al., 1998) that can estimate, represent and also validate linear relations among the observable and latent variables within a hypothesised network (Jöreskog & Sörbom, 1996; Molenaar et al., 2000). SEM can reduce the noted limitations of MRA because it includes errors of measurements for a large number of variables, providing a more accurate representation of the results within a model (Molenaar et al., 2000).

The computer packages SPSS and Analysis of Moment Structures (AMOS) version 26.0 were used for the SEM analysis. Goodness of fit (GOF) indices available from AMOS such as root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), Tucker-Lewis index (TLI) and normal fit index (NFI) were used to assess the fitness of the relationships and the model. The recommended acceptance thresholds of the GOF indices are shown in Table 1.

Table 1 Goodness-of-fit (GOF) measures recommended levels

Goodness-of-fit (GOF) measure	Recommended acceptance thresholds of the GOF indices
Goodness-of-fit index (GFI)	0 (No fit) to 1 (Perfect fit)
RMSEA	<0.05 indicates very good fit – threshold level is 0.10
Tucker-Lewis index (TLI)	0 (No fit) to 1 (Perfect fit)
Normal fit index (NFI)	0 (No fit) to 1 (Perfect fit)

Source: Table format adopted from Molenaar et al. (2000)

Refinements are required if the model does not meet the recommended thresholds in Table 1. AMOS provides modification recommendations on how to improve the GOF values, however these should only be undertaken if they are theoretically and practically justifiable (Arbuckle & Wothke, 1999). Modifications can include 'revising relationships paths and adding covariance error paths between observed and latent variables' (P. S. P. Wong, Demertjis, Hardie, & Lo, 2014, p. 205).

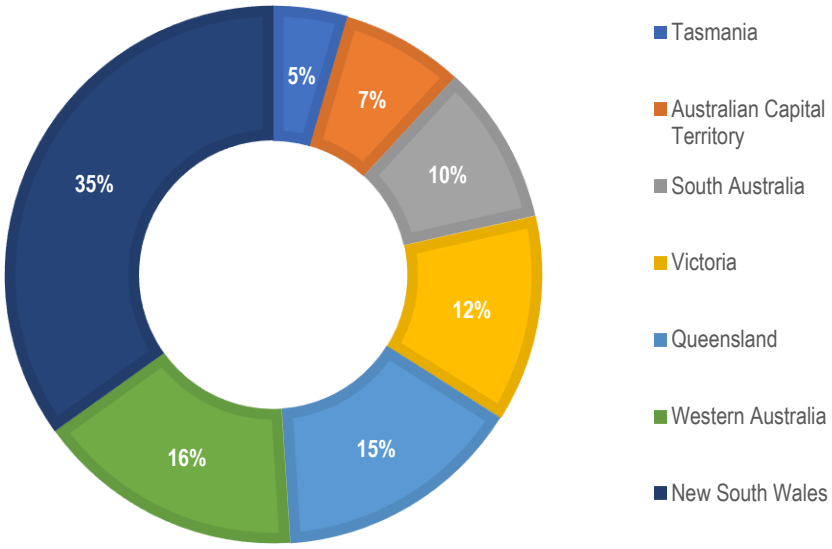
3. Results

This section begins with an overview of demographic data collected in the survey to present the profile of respondents surveyed. Section 3.2 compares the means, along with statistically significant relevant one-way ANOVA results for existing training practices. Section 3.3 then compares the means and one way ANOVA for awareness and training practices for working with hydrogen. Section 3.4 then explores the TPB framework's relationship with respondent existing training behaviour and Section 3.5 does the same with regards to future hydrogen training. The conceptual and final TPB models are presented in Section 3.6 for existing training and 3.7 for future hydrogen training.

3.1 Respondent profile

Of the 1001 responses, just over a third (34%) of respondents were in New South Wales, followed by 16% in Western Australia, 15% in Queensland, 12% in Victoria and 10% in South Australia. Australian Capital Territory and Tasmania had 7% and 5% of respondents respectively. Percentages of respondents in each state are shown in Figure 3.

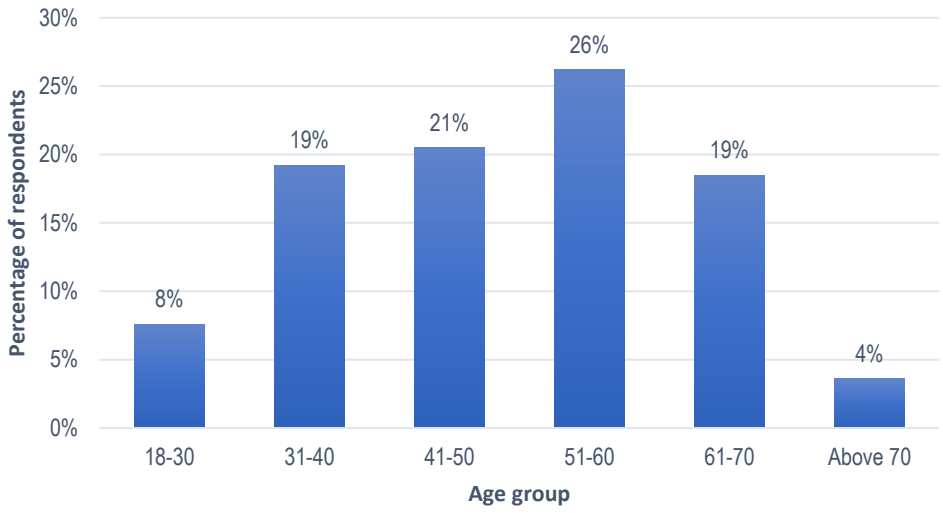
Figure 3 Respondents by location



Of the 1001 respondents, 7 (0.7%) were female and 1 was 'other', the remaining percentage (99%) were male. This is reflective of the percentage of females working in the plumbing trade who, according to ABS data, made up 1.7% of the Australian plumbing workforce in 2020 (ABS, 2022).

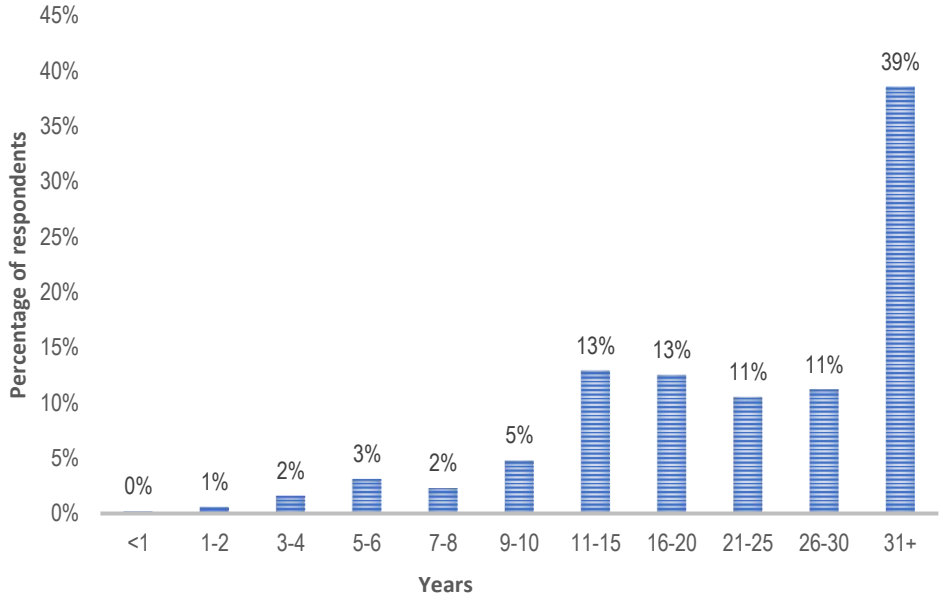
As shown in Figure 4, below, the respondents' ages ranged from 15 to 85 years with 26% aged between 51 years and 60, 21% between 41 and 50, 19% between 31-40 and 19% between 61 and 70. Four percent of respondents were aged over 70 and 7.6% were aged 30 or under.

Figure 4 Respondent Age



Respondents were asked about how many years they had been working as a plumber/gasfitter. Over a third (n=38.5) had 31 years or more experience, while 22% had 21 to 31 years experience, 25% had 11 to 20 years experience and 13% had 10 or less years' experience.

Figure 5 Experience in years



Respondents were also asked about what type of plumbing and/or gasfitting work they undertake. As shown in Table 2 approximately one third (34%) of respondents undertook mostly plumbing work with some gasfitting, and approximately one third (33%) undertook half plumbing and half gasfitting work. Less than 1% of respondents undertook only plumbing work with no gasfitting and therefore 99% of respondents were experienced with gasfitting work.

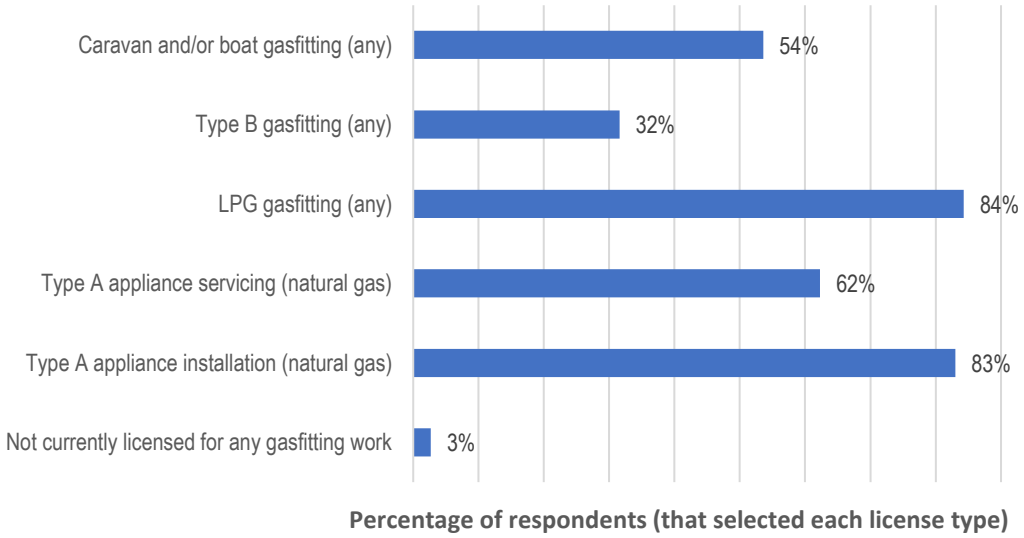
Table 2 Type of plumbing and/or gasfitting work performed

	n	Percent
Mostly plumbing (other than gasfitting) with some gasfitting	336	35
Half plumbing (other than gasfitting) and half gasfitting	328	34
Only gasfitting	165	17

Mostly gasfitting with some plumbing (other than gasfitting)	131	14
Only plumbing (other than gasfitting)	9	1
Total	**969**	**100.0**

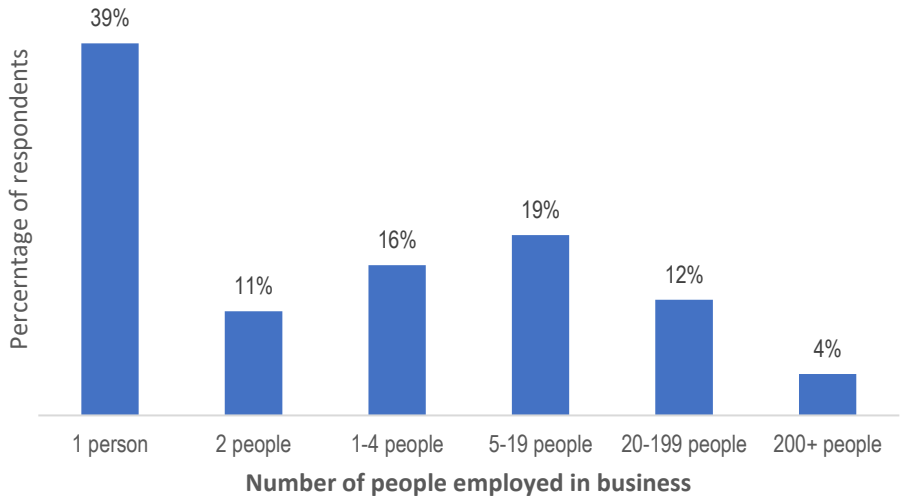
Respondents held a range of licence types as shown in Figure 6. For this question, respondents were able to select more than one response due to the structure of plumbing license type that allows plumbers to be licenced in one or more categories/classes of plumbing. Eighty three per cent of respondents were licensed in Type A gasfitting installation (natural gas) and 84% were licensed to undertake LPG work. Sixty-two percent were licensed to undertake Type A servicing (natural gas) and 32% were licensed for Type B gasfitting. Finally, 54% were licensed for caravan and/or boat gasfitting and 3% were not currently licensed to undertake any gasfitting work. Note that this figure for those not licensed to undertake gasfitting work differs to the less that 1% who reported that they do not undertake any gasfitting work above (see Table 2). It may be that there was a reporting error for work or license type or that a small percentage undertake gasfitting work without the appropriate license.

Figure 6 Plumbing licences held by respondent



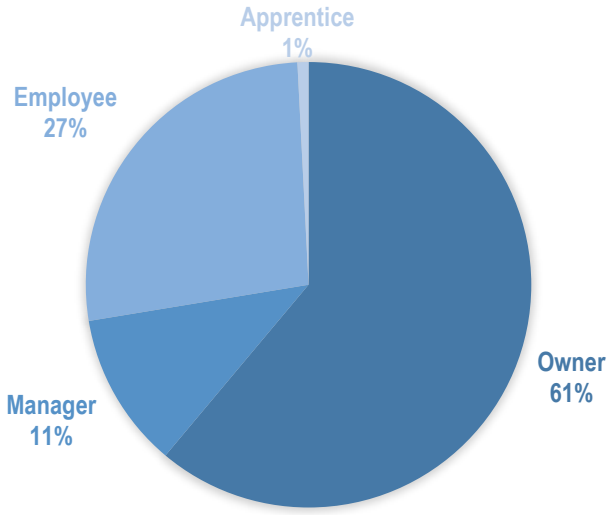
Respondents were asked to identify the size of the business they worked in and their role with 39% of respondents citing they worked alone, 26% worked in businesses with 2 to 4 people and 19% worked with 5-19 people. These results indicate that 84% of respondents worked in small businesses reflecting the predominantly sole trader and small business structure of the plumbing industry (Kelly, 2020). The remaining 12% of respondents worked in medium size businesses employing 20-199 people and 4% worked in large businesses (See Figure 7).

Figure 7 Number of people employed in business



The data presented in Figure 8 illustrates 61% of respondents were in the role of business owner, 11% were managers and 27% were employees. Less than 1% were apprentices. This figure is not surprising given that the survey was communicated through existing regulatory and industry associations and not targeted directly to apprentices via training organisations.

Figure 8 Respondent role



Respondents were asked about the type of work they undertake and had the ability to select more than one answer. There were 1723 responses in total. The data in Figure 9 shows that respondents undertook work in mostly single dwelling (699 respondents) and commercial work such as restaurants and offices (649 respondents). Just over a third of respondents (n=375), undertook work in multi-residential buildings.

Figure 9 Type of work undertaken

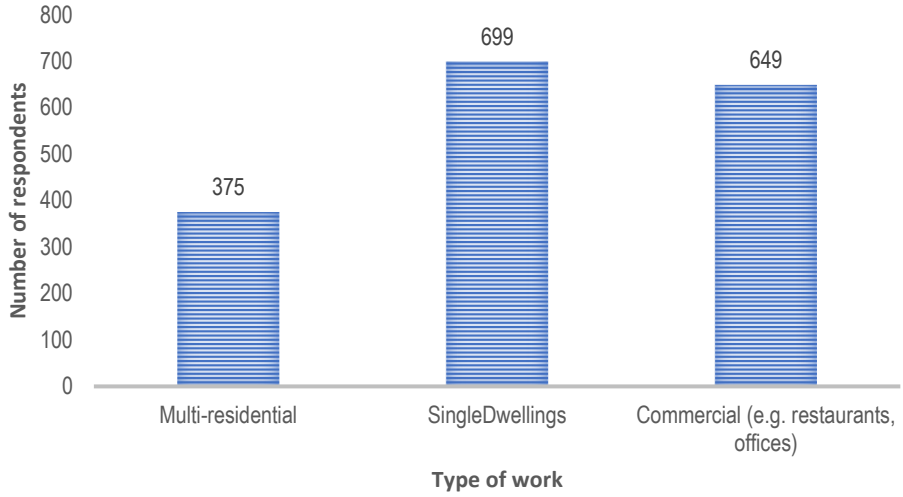
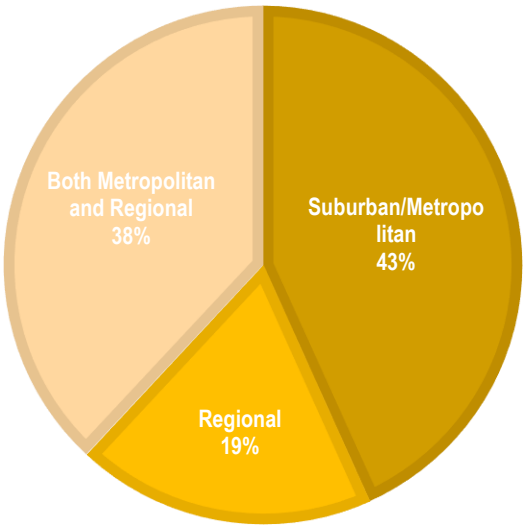


Figure 10 indicated that 44% of respondents worked in suburban/metropolitan areas, while 19% undertook work in only regional areas and 38% undertook work in both suburban/metropolitan and regional areas.

Figure 10 Location of work undertaken



Respondents were able to select multiple responses when asked about what qualifications they had completed. As presented in Table 3, 63% of respondents had completed a Certificate IV in Plumbing and Services, 62% of respondents had completed a Certificate III in Gasfitting, and 53% had completed a Certificate III in Plumbing.

Table 3 Qualifications

	n	Percent of total cases
Certificate IV in Plumbing and Services	617	63
Certificate III in Gas Fitting	609	62
Certificate III in Plumbing	519	53
Service Type A gas appliances (single Unit of Competency)	448	46
Certificate III in Roof Plumbing	318	33
Certificate III in Plumbing (Mechanical Services)	273	28
Install, commission and service Type B gas appliances (single Unit of Competency)	243	25
Certificate II in Drainage	220	23

Certificate II in Plumbing	201	21
Certificate I in Plumbing Services	185	19
Other	150	15
Totals	**3783**	

3.2 Comparing the means: Current training practice

3.2.1 Attitudes about training and outcomes and intention to undertake training

Means and their standard deviations (SD) were calculated for the responses to the survey questions related to the TPB model. For questions regarding attitudes and intentions, strongly disagree was coded as 1; somewhat disagree coded 2; neither agree nor disagree coded 3; somewhat agree coded 4; strongly agree coded 5.

As illustrated in Table 4 below all respondents agreed that they had a positive attitude to undertaking additional training relevant to their trades practice (Mean = 4.42, SD = .956) and that they had had positive experiences undertaking training in the past (Mean = 4.22, SD = .976). Respondents also agreed that in the future, they intend to undertake additional training (for example a course or seminar) relevant to their plumbing/gas fitting work (Mean = 4.11, SD = 1.085). A one-way ANOVA revealed that there was a statistically significant difference in intention to undertake training in the future between New South Wales (Mean = 3.92) and Tasmania (Mean = 4.64) ($F(30.924, 1107.426) = 3.854$, $p < .001$). The significant difference in the responses between these two groups may be a result of compulsory CPD associated with licensing in Tasmania. See Appendix 7.3 for ANOVA results tables.

Table 4 Training attitudes and intentions

	Mean	SD
I have a positive attitude towards undertaking additional training relevant to my trade practice	4.42	0.96
In the past, I have had positive experiences undertaking training relevant to my trade practice	4.22	0.98
In the future, I intend to undertake additional training (for example a course or seminar) relevant to my plumbing/gas fitting work	4.11	1.09

Respondents felt that ongoing training post completion of their plumbing certification was beneficial for their trade practice for various reasons as indicated in Table 5. Respondents were in agreement that all 11 listed aspects of their trade practice were benefited by them undertaking additional training, with the mean ranging from 4.10 to 4.53. The results indicated that training was associated with an increase in skills and knowledge important to ensure industry currency.

Table 5 Benefits of undertaking additional training

	Mean	SD
Adding to my skills/knowledge in plumbing/gasfitting	4.53	0.87
Increasing my skills/knowledge to ensure safe work practices for customers	4.45	0.92
Providing advice to customers about products and services	4.42	0.94
Providing assistance or advice to colleagues about products and practices	4.38	0.94
Helping me to meet the requirements of the technical standards	4.37	0.93
The long-term viability of my plumbing/gasfitting trade	4.32	1.01
The quality of the work I undertake	4.32	1.00
Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	4.21	1.06
Helping me meet my trade licensing requirements	4.17	1.04
The short to medium term competitiveness of the business I work in/own	4.10	1.02
Increasing my career opportunities	4.10	1.07

A one-way ANOVA revealed that there was a statistically significant difference in the perceived benefits of undertaking additional training for increasing carrier opportunities between those respondents aged 61-70 years (Mean = 3.78) and those respondents aged 18-31 years (Mean = 4.55) ($F(64.329, 1020.003) = 11.731$, $\rho < .001$), and owners of their own business (Mean = 4.01) and apprentices (Mean = 4.88), ($F(14.119, 1084.647) = 4.157$, $p < .001$). See Appendix 7.3 for ANOVA results tables. Older respondents were less enthusiastic regarding the benefits of training than younger respondents. Those respondents aged 31 years and under are beginning their

careers and likely to have a different view of 'career opportunities' placing a greater value on training than those respondents of retirement age (60-70 years). Likewise, business owners have established themselves in the industry and saw less benefit in additional training for themselves, compared with apprentices who may be more inclined to consider career opportunities because of their age and role. Having said that, the means indicate that all ages and all roles see benefit in additional training.

3.2.2 Actual training behaviour

Means and their standard deviations (SD) were calculated for the responses regarding actual training behaviour over the 3 years prior to completing the survey. For this question, *not at all* was coded as 1; *rarely (1-2 times in the last 3 years)* was coded at 2; *sometimes (3-6 times in the last 3 years)* was coded at 3; *often (approx. monthly)* was coded at 4; and *very often (approx. weekly)* coded 5.

The mean for this question was 2.34 (SD 1.041) indicating that training was sometimes undertaken over the past 3 years. In the response items, sometimes was defined as '3 to 6 times in the past three year period'. As a result, depending on the type of training undertaken and the amount of industry changes to necessitate training, this may be deemed enough training to have undertaken to keep up to date with practice requirements. It is important to also note that training and work activities in 3 year period prior to the survey would likely have been impacted by COVID-19 disruptions, however it is not known if and how COVID-19 disruptions to regular work practices or availability and delivery of training during this period may have influenced the frequency of respondents training activities.

A one-way ANOVA revealed that there was a statistically significant difference in actual training practices between at those aged 70 and over (Mean = 1.94) and those aged 18-30 (Mean = 2.64) ($F(24.521, 1012.158) = 4.584$, $\rho < .001$), those located in New South Wales (Mean = 2.14) and Tasmania (Mean = 3.34) ($F(76.638, 978.945) = 10.815$, $\rho < .001$). See Appendix 7.3 for ANOVA results tables. It is likely that that a higher percentage of those aged 18-30 have undertaken or completed plumbing qualifications more recently than those in the older age brackets, and therefore a higher mean can be expected from the 18-31 year old respondent group. Overall, however, the means for both age groups and also New South Wales compared with Tasmania are relatively low indicating that no independent variables (demographics) had a large impact on actual training practices over the past 3 years.

3.2.3 Perceived social pressure to undertake training from key stakeholders

Respondents were asked to identify the people that influenced their trade practice. Means and standard deviations were calculated where: Strongly disagree was coded as 1; somewhat disagree coded 2; neither agree nor disagree coded 3; somewhat agree coded 4; strongly agree coded 5. As shown in Table 6, respondents agreed that the regulator was the most influential on their practice (Mean = 4.37, SD = .856) followed by customers (mean = 4.05, SD = 1.001). Colleagues/Peers, Suppliers/manufacturers, Employer, Insurers, Associations, Family and Friends were somewhat influential with means ranging from 3.08 to 3.99 and unions were not influential (mean = 2.63, SD 1.215). Given a large proportion of respondents work in domestic plumbing it can be assumed that this is a largely ununionized workforce reflected in the lack of influence of the union in our results.

A one-way ANOVA revealed that there was a statistically significant difference in people and groups that are influential on respondents' trade practice between business owners and apprentices. The apprentice group agreed that the customers, colleagues and peers, employer were influential which differed to owners who neither agreed nor disagreed that these same groups were influential. See Appendix 7.3 for ANOVA results tables.

Table 6 People and groups that are influential on respondents' trade practice

	Mean	SD
Regulator	4.37	0.86
Customers	4.05	1.00
Colleagues/Peers	3.99	0.92
Suppliers/manufacturers	3.92	0.95
Employer (if not self-employed)	3.90	0.97
Insurers	3.71	1.06
Associations for which I am a member of (e.g. Master Plumbers)	3.53	1.10
Family	3.21	1.11

Friends	3.08	1.05
Unions	2.63	1.22

Respondents were then asked, using the same scale of agreement/disagreement as above, whether the same groups of people would show their support/encouragement if the respondent undertook further training relevant to their trade. Table 7 shows that respondents agreed that the regulator would show their support (mean = 4.07, SD 1.053), while other groups had a mean ranging from 3.39 to 3.91. It can be inferred that these groups did not have a strong influence on the uptake of additional training for the respondents.

Table 7 People and groups that encourage respondents to undertake training

	Mean	SD
Regulator	4.07	1.05
Employer (if not self-employed)	3.91	1.01
Colleagues/Peers	3.85	0.98
Suppliers/manufacturers	3.71	1.03
Customer	3.66	1.11
Associations for which I am a member of (e.g. Master Plumbers)	3.62	1.10
Insurers	3.61	1.12
Family	3.56	1.09
Friends	3.39	1.06
Unions	2.83	1.20

Data shown in Table 7 combined with data from Table 6 identifies that the regulator is perceived as the most encouraging/supportive of respondents undertaking training and is also the most influential on the respondents' training practice. It can therefore be inferred that the regulator has an important role in influencing practices and encouraging future training. However, a one-way ANOVA revealed that there was a statistically significant difference between respondents from Western Australia (Mean = 3.93) and Tasmania (Mean = 4.56) and the encouragement of training practice by the regulator ($F(18.153, 1035.872) = 2.376$, $\rho = .021$). These results could be explained by the continuing professional development requirements recently introduced in Tasmania as part of licensing renewal. The means for other states were between these figures and differences are not statistically significant compared to the whole sample.

A one-way ANOVA also revealed a statistically significant difference in people and groups that encourage respondents to undertake training between the owners and apprentice groups. The apprentice group agreed that colleagues and peers, friends, family and employer were encouraging of training which differed to owners who neither agreed nor disagreed that these same groups encourage training. See Appendix 7.3 for ANOVA results tables.

Respondents were also asked, from the same groups, who discourages them from undertaking training. The data aligned with that of the encouragement question, that is, that those who would encourage training, were not likely to discourage training and thus validates the subjective norm responses.

3.2.4 Perceived behavioural controls enabling or preventing training

Respondents were asked three questions regarding their perceptions of the external factors that enable or prevent them from undertaking training. Means and standard deviation for these behavioural control questions were calculated as above where: Strongly disagree was coded as 1; somewhat disagree coded 2; neither agree nor disagree coded 3; somewhat agree coded 4; strongly agree coded 5.

The respondents indicated that they were able to undertake training if they wanted to when asked if undertaking further training was up to them (mean = 4.35, SD .982). This indicates a strong perception that respondents have the ability and opportunity to undertake training if they wish. Respondents were then asked to rate their agreement about whether 8 factors enabled them to undertake training. As shown in Table 8, there was strong agreement that the availability of training opportunities provided by TAFEs or other training organisations (mean = 4.33, SD = 1.004) and the regulator (mean = 4, SD 1.087) enabled respondents to undertake further training. Licensing requirements were also a strong enabling factor for undertaking further training (mean = 4.15, SD = .983).

Table 8 Factors enabling respondents to undertake further training

	Mean	SD
Availability of training opportunities provided by TAFEs or other training organisations	4.33	1.00
Licensing requirements	4.15	0.98
Availability of training opportunities provided by regulators	4.00	1.09
Availability of training opportunities provided by suppliers or manufacturers	3.96	1.03
Availability of training opportunities provided by associations (e.g Master Plumbers)	3.86	1.15
Time taken by training	3.86	1.11
Cost of training	3.78	1.17
Travel distance for training	3.78	1.11

When asked about whether the same factors as above prevented or discouraged the respondents training activities, all factors had a mean score ranging from 3.16 to 3.58 (see Table 9) which indicates that none of the factors were perceived as preventing or discouraging training.

Table 9 Factors preventing/discouraging respondents to undertake further training

	Mean	SD
Cost of training	3.58	1.22
Travel distance for training	3.53	1.22
Time taken by training	3.5	1.24
Availability of training opportunities provided by TAFEs or other training organisations	3.3	1.38
Availability of training opportunities provided by regulators	3.21	1.31
Licensing requirements	3.17	1.30
Availability of training opportunities provided by associations (e.g. Master Plumbers)	3.16	1.29
Availability of training opportunities provided by suppliers or manufacturers	3.16	1.28

3.2.5 Sources of learning

Respondents were also asked about where they gain information from or what informs their learning. For this question, respondents were asked to rate their level of agreement against 19 potential sources of information/learning. Means and standard deviation for the question were calculated as above where: never was coded as 1; sometimes coded at 2; about half the time coded 3; most of the time coded 4; always coded 5.

The data presented in Table 10 illustrates that regulatory authorities had the highest mean of 3.26, indicating that regulators were used by respondents 'about half the time' to gain information. This was followed by employers, business colleagues, manufacturers, peers/networks, suppliers, websites, TAFE providers and associations who were used 'sometimes' (means ranged from 2.38 to 2.95) as an information/learning source. This shows that, rather than relying on just one or two sources, respondents are getting information from a range of the above sources to inform their practice with the regulator being the most frequently used source. Respondents indicated that banks, lawyers, unions, insurance companies, accountants, family, social media, YouTube, apprentices or customers were never a source of learning/information (means ranged from 1.27 to 1.77).

Table 10 Sources of learning/information for trade practice

	Mean	SD
Regulatory authorities	3.26	1.20
Employer	2.95	1.39
Colleagues in my business (not apprentices)	2.92	1.20
Manufacturers	2.9	1.10
Peers/informal networks outside of my business	2.85	1.16
Suppliers	2.7	1.02
Websites	2.6	1.11
TAFE providers	2.56	1.30
Associations (e.g. Master Plumbers)	2.38	1.20
Customers	1.77	0.90
Apprentices	1.76	0.89
YouTube	1.7	0.91
Social media	1.57	0.86
Family	1.53	0.86

Accountants	1.49	0.88
Insurance companies	1.45	0.83
Unions	1.4	0.87
Lawyers	1.33	0.77
Banks	1.27	0.69

A one-way ANOVA revealed that there was a statistically significant difference in sources of learning/information between the owners and apprentice groups. The apprentice group agreed that peers/informal networks outside of their business and their employer were sources of learning/information which differed to owners who somewhat disagreed that these same groups were sources of learning/information. A one-way ANOVA also revealed that there was a statistically significant difference in frequency of the use of sources of learning/information between the employer (Mean = 2.51) and apprentice (Mean = 4.25) groups regarding TAFE providers. See Appendix 7.3 for ANOVA results tables.

3.3 Comparing the means: Future hydrogen training

Respondents were asked a series of questions in the context of hydrogen to firstly ascertain their level of knowledge of hydrogen and the development of a hydrogen industry ,secondly, their intentions, beliefs and subjective norms in relation to hydrogen, and finally their preferences for hydrogen training delivery. For all questions, respondents were asked to rate their level of agreement with each question statement. Means and standard deviation for question were calculated where: Strongly disagree was coded as 1; somewhat disagree coded 2; neither agree nor disagree coded 3; somewhat agree coded 4; strongly agree coded 5.

3.3.1 Awareness of hydrogen

Respondents somewhat disagreed that they were confident in describing the properties of hydrogen (mean = 2.95, SD = 1.389). A similar result was found when respondents were asked about their confidence in describing Australia's plans for a future hydrogen industry to others (mean = 2.68, SD = 1.373) (See Table 11). This indicates that respondents' perceived level of both technical and policy level understanding of hydrogen is low. .

Table 11 Awareness of hydrogen

	Mean	SD
I am confident in describing the properties/characteristics of hydrogen gas to others	2.95	1.39
I could describe Australia's plans for a future hydrogen industry to others	2.68	1.37

3.3.2 Intention to undertake hydrogen training in the future

Respondents were presented with a short description about the role hydrogen could play as a replacement for natural gas and government plans for a future hydrogen industry. Respondents agreed (mean = 4.62, SD .712) that if hydrogen training were available, they would undertake such training. This indicates that while existing awareness of hydrogen and future hydrogen industry plans are low amongst respondents, there is a high level of interest in undertaking training for hydrogen.

3.3.3 Beliefs and attitudes about hydrogen training and outcomes

Respondents expressed agreement that undertaking training to work with hydrogen would be beneficial for a range of different aspects of their trade practice. As shown in Table 12, respondents were in agreement that all 11 listed aspects of their trade practice would be benefited by them undertaking additional training, with the mean ranging from 4.32 to 4.68. The data indicates that all respondents recognise there are benefits to undertaking training for a variety of reasons presented in Table 12.

Table 12 Benefits of undertaking hydrogen training

	Mean	SD
Adding to my skills/knowledge in plumbing/gasfitting	4.68	0.66
Increasing my skills/knowledge to ensure safe work practices for customers	4.65	0.68
Providing advice to customers about products and services	4.56	0.78
Helping me to meet the requirements of the technical standards	4.54	0.80
The long-term viability of my plumbing/gasfitting trade	4.50	0.86

Providing assistance or advice to colleagues about products and practices	4.49	0.80
Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	4.47	0.88
Helping me meet my trade licensing requirements	4.41	0.90
The quality of the work I undertake	4.38	0.96
Increasing my career opportunities	4.35	0.94
The short to medium term competitiveness of the business I work in/own	4.32	0.94

3.3.4 Perceived social pressure to undertake hydrogen training from key stakeholders

Respondents were asked which groups of people they believed would support/encourage them if they undertook hydrogen training. The same 11 groups from the question reported in Section 3.2.3 regarding subjective norms in current trades training practice, were listed. Table 13 indicates that respondents agreed that the regulator would show their support (mean = 4.23, SD .989) and their employer (mean = 4.03, SD 1.080), while other groups had a mean ranging from 3.43 to 3.95 indicating that these groups did not have as strong influence on the uptake of hydrogen training for the respondents. Unions were least supportive with a mean of 2.99 and when combined with the data from Table 6, this suggests that they do not play a role in respondent training behaviour overall. Again, many of the respondents were non-union labour as they work in the domestic market.

A one-way ANOVA revealed that there was a statistically significant difference in people and groups that would encourage respondents to undertake hydrogen training between apprentice and manager and employee groups. The apprentice group agreed that family (Mean = 4.50) would support them which differed to employees who neither agreed nor disagreed that family would be supportive (Mean = 3.57). Unions were another point of difference between the apprentice group (Mean = 4) and the manager group (2.89). See Appendix 7.3 for ANOVA results tables.

Table 13 People and groups that would encourage respondents to undertake hydrogen training

	Mean	SD
Regulator	4.23	0.99
Employer (if not self-employed)	4.03	1.08
Suppliers/manufacturers	3.95	0.99
Colleagues/Peers	3.92	1.01
Associations for which I am a member of (e.g. Master Plumbers)	3.82	1.09
Family	3.59	1.17
Insurers	3.59	1.16
Customer	3.57	1.17
Friends	3.43	1.13
Unions	2.99	1.29

Respondents were also asked who, from the same groups, would discourage them from undertaking hydrogen training. The data aligned with that of the encouragement question, that is, that those who would encourage hydrogen training, were not likely to discourage hydrogen training and thus validates the subjective norm responses.

3.3.5 Perceived behavioural controls enabling or preventing training

Given there is currently no hydrogen training widely available to plumber/gas fitters, perceived behavioural controls for undertaking hydrogen were not included in the survey. This study has assumed that the behavioural controls for current training practices reported on in section 3.2.4 would apply to future hydrogen training also. In the models presented in later sections of the results, the data from preferences for hydrogen training delivery (means shown in the following section) has been used as indicators for behavioural controls for hydrogen training.

3.3.6 Preferences for hydrogen training delivery

Respondents were asked to rate their level of agreement with 13 different delivery options for hydrogen training. When asked about their preferences for delivery of hydrogen training across 13 different types of training and durations the highest mean score aligned to face-to-face training (mean = 4.41, SD = 0.847). As demonstrated in

Table 14, following face-to-face training, the next most popular response was a course at TAFE or another training provider with a duration of less than 1 week (mean = 4.35, SD = 1). Respondents also expressed agreement with undertaking training sessions with a regulator (mean = 4.17, SD 0.981) and with a supplier/manufacturer (mean = 4, SD = 1.011).

Weekend training was least preferred by respondents (mean = 3.13, SD = 1.45), along with training that was spread out over time (mean = 3.57, SD = 1.248) and a course at TAFE longer that one week in duration (mean = 3.69, SD = 1.286). This indicates overall that respondents preferred an intensive, face-to-face course with a training provider, regulator or supplier/manufacturer and for the training to be less than one week in duration.

In terms of the timing of the training, given respondents' lack of agreement with weekend training, it may be the case that respondents prefer weekday training, although this specific item was not included in the survey question. Preferences for daytime and evening training were relatively similar with a means for evening training of 3.87, SD 1.197, and for daytime training a means of 3.89, SD 1.148.

Table 14 Preferences for hydrogen training delivery

	Mean	SD
Face to face training	4.41	0.85
A course with TAFE or other training provider (less than 1 week)	4.35	1.00
Training sessions with regulator	4.17	0.98
Training with a supplier/manufacturer	4	1.01
Intensive training	3.95	1.12
Onsite training (workplace training)	3.92	1.17
Training sessions with an association	3.91	1.08
Daytime training	3.89	1.15
Evening training	3.87	1.20
Online training	3.82	1.27
A course with TAFE or other training provider (more than 1 week)	3.69	1.29
Staggered training (sessions spread out over time)	3.57	1.25
Weekend training	3.13	1.45

A one-way ANOVA revealed that there was a statistically significant difference in hydrogen training preferences between the apprentice group and the owner group. The apprentice group agreed that training at TAFE or other training organisation for more than 1 week would be preferable (Mean = 4.63) which differed to owners who neither agreed nor disagreed with such training (Mean = 3.61). A one-way ANOVA also revealed that the apprentice group agreed with onsite training (Mean = 4.63) which differed to owners who neither agreed nor disagreed (Mean = 3.84). See Appendix 7.3 for ANOVA results tables. This difference could be due to apprentices' current training requirements which involves ongoing training with a training provider and also workplace training, both characteristic of the apprenticeship qualification model.

3.4 TPB and its relationship existing training behaviour

This section presents the Pearson product–moment correlation coefficients (*r*) for actual training behaviour and training intention and the relationships with respondents' behavioural beliefs, subjective norms and behavioural controls regarding existing training behaviour.

3.4.1 Actual training behaviour and intention to train and behavioural beliefs about training

Analysis of the relationship between respondents' **actual training behaviour** and their beliefs about training is shown in Table 15. The results indicate that there is a weak positive correlation between actual training behaviour and the behavioural beliefs about training. This applies to all operational statements indicating that behavioural beliefs about the benefits of training have no significant impact on actual training behaviour.

Table 15 Relationship between actual training behaviour and behavioural beliefs about training

Behavioural beliefs	Pearson Correlation	Sig. (2-tailed)
Increasing my career opportunities	.189**	0.000
The long-term viability of my plumbing/gasfitting trade	.179**	0.000
The quality of the work I undertake	.178**	0.000

Providing assistance or advice to colleagues about products and practices	.170**	0.000
The short to medium term competitiveness of the business I work in/own	.166**	0.000
Increasing my skills/knowledge to ensure safe work practices for customers	.163**	0.000
Adding to my skills/knowledge in plumbing/gasfitting	.162**	0.000
Helping me to meet the requirements of the technical standards	.154**	0.000
Providing advice to customers about products and services	.152**	0.000
Helping me meet my trade licensing requirements	.144**	0.000
Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	.129**	0.000

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Analysis of the relationship between respondents' **intention to undertake training** and their beliefs about training is shown in Table 16. The results indicate that there is a weak to moderate positive correlations between intention to undertake training and the beliefs about training, indicating a slightly more significant relationship between variables than actual training behaviour. The short to medium term competitiveness of the business I work in/own was the benefit that had the strongest positive correlation with intention to train (*r*= .406).

Table 16 Relationship between intention to train and behavioural beliefs about training

Behavioural beliefs	Pearson Correlation	Sig. (2-tailed)
The short to medium term competitiveness of the business I work in/own	.406**	0.000
The quality of the work I undertake	.399**	0.000
Adding to my skills/knowledge in plumbing/gasfitting	.397**	0.000
The long-term viability of my plumbing/gasfitting trade	.371**	0.000
Providing advice to customers about products and services	.364**	0.000
Increasing my career opportunities	.357**	0.000
Increasing my skills/knowledge to ensure safe work practices for customers	.355**	0.000
Providing assistance or advice to colleagues about products and practices	.354**	0.000
Helping me to meet the requirements of the technical standards	.349**	0.000
Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	.344**	0.000
Helping me meet my trade licensing requirements	.288**	0.000

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

3.4.2 Actual behaviour and intention to train and support from subjective norm groups

Analysis of the relationship between respondents' **actual training behaviour** and their perceptions of subjective norms related to training is shown in Table 17. The results indicate a weak positive correlation between subjective norms and actual training behaviour.

Table 17 Relationship between actual training behaviour and subjective norms

Supportive subjective norms	Pearson Correlation	Sig. (2-tailed)
Employer (if not self-employed)	.204**	0.000
Colleagues/Peers	.150**	0.000
Associations for which I am a member of (e.g. Master Plumbers)	.149**	0.000
Family	.125**	0.000
Friends	.089**	0.006
Regulator	.076*	0.019
Customer	.072*	0.025
Suppliers/manufacturers	.061	0.062
Insurers	.035	0.282
Unions	.003	0.921

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Analysis of the relationship between respondents' **intention to undertake training** and their perceptions of subjective norms related to training is shown in Table 18. The results indicate that there is a weak positive correlation between the intention to undertake training and the subjective norm groups.

Table 18 Relationship between intention to undertake training and subjective norms

Supportive subjective norms	Pearson Correlation	Sig. (2-tailed)
Colleagues/Peers	.262**	0.000
Family	.233**	0.000
Customer	.223**	0.000
Employer (if not self-employed)	.219**	0.000
Regulator	.209**	0.000
Associations for which I am a member of (e.g. Master Plumbers)	.205**	0.000
Insurers	.196**	0.000
Friends	.191**	0.000
Suppliers/manufacturers	.188**	0.000
Unions	.119**	0.000

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

3.4.3 Actual behaviour and intention to train and enabling behavioural controls

Analysis of the relationship between respondents' **actual training behaviour** and their perceptions about behavioural controls is shown in Table 19. The results indicate that there is no relationship between respondents actual training behaviour and their perceived positive behavioural controls.

Table 19 Relationship between actual training behaviour and behavioural controls

Enabling behavioural controls	Pearson Correlation	Sig. (2-tailed)
Availability of training opportunities provided by associations (e.g Master Plumbers)	.099**	0.002
Licensing requirements	.030	0.351
Availability of training opportunities provided by regulators	.026	0.414
Time taken by training	.025	0.448
Availability of training opportunities provided by TAFEs or other training organisations	.019	0.555
Availability of training opportunities provided by suppliers or manufacturers	.012	0.715
Cost of training	.012	0.721
Travel distance for training	.010	0.760

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Analysis of the relationship between respondents' **intention to undertake training** and their perceptions about behavioural controls is shown in Table 20. The results indicate a higher positive relationship with the same behavioural control variables and intention to undertake training as above, however these correlations are still week.

Table 20 Relationship between intention to undertake training and behavioural controls

Enabling behavioural controls	Pearson Correlation	Sig. (2-tailed)
Availability of training opportunities provided by associations (e.g Master Plumbers)	.155**	0.000
Availability of training opportunities provided by TAFEs or other training organisations	.129**	0.000
Availability of training opportunities provided by regulators	.129**	0.000
Availability of training opportunities provided by suppliers or manufacturers	.124**	0.000
Licensing requirements	.105**	0.001
Time taken by training	.102**	0.002
Cost of training	.083**	0.01
Travel distance for training	.053	0.104

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

3.5 TPB and its relationship future hydrogen training behaviour

This section presents the Pearson product–moment correlation coefficients (*r*) for respondent intention to undertake hydrogen training behaviour and the relationships with respondents' behavioural beliefs, subjective norms and behavioural controls regarding hydrogen training.

3.5.1 Intention to undertake hydrogen training and beliefs about hydrogen training

Analysis of the relationship between respondents' **intention to undertake hydrogen training** and their beliefs about hydrogen training is shown in Table 18. The results indicate a moderate positive correlation between beliefs about the outcomes of hydrogen training and respondents' intention to undertake hydrogen training in the future.

Table 21 Relationship between intention to undertake hydrogen training and behavioural beliefs about hydrogen training

Behavioural beliefs	Pearson Correlation	Sig. (2-tailed)
The long-term viability of my plumbing/gasfitting trade	.594**	0.000
Increasing my skills/knowledge to ensure safe work practices for customers	.566**	0.000
Adding to my skills/knowledge in plumbing/gasfitting	.553**	0.000
Providing assistance or advice to colleagues about products and practices	.515**	0.000
Providing advice to customers about products and services	.510**	0.000
The short to medium term competitiveness of the business I work in/own	.507**	0.000
Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	.500**	0.000
Helping me to meet the requirements of the technical standards	.491**	0.000
The quality of the work I undertake	.476**	0.000
Increasing my career opportunities	.467**	0.000
Helping me meet my trade licensing requirements	.433**	0.000

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

3.5.2 Intention to undertake hydrogen training and support from subjective norm groups

Analysis of the relationship between respondents' **intention to undertake hydrogen training** and their perceptions of subjective norms related to hydrogen training is shown in Table 22. The results indicate a weak to moderate positive relationship between respondents intention to undertake hydrogen training and the subjective norm groups. The regulator had the strongest positive impact on the intention to undertake hydrogen training in the future (*r*=.409)

Table 22 Relationship between intention to undertake hydrogen training and subjective norms for hydrogen training

Supportive subjective norms	Pearson Correlation	Sig. (2-tailed)
Regulator	.409**	0.000
Employer (if not self-employed)	.385**	0.000
Colleagues/Peers	.363**	0.000
Associations for which I am a member of (e.g. Master Plumbers)	.322**	0.000
Suppliers/manufacturers	.302**	0.000
Family	.282**	0.000
Customer	.264**	0.000
Insurers	.243**	0.000
Friends	.237**	0.000
Unions	.167**	0.000

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

3.5.3 Intention to undertake hydrogen training and enabling behavioural controls

Analysis of the relationship between respondents' **intention to undertake hydrogen training** and their perceptions about enablers for hydrogen training is shown in Table 23. The results indicate a weak correlation between respondents' intention to undertake hydrogen training and the training options that would enable them to undertake such training. The strongest positive correlation was face-to-face training (*r*=.318) however this correlation is still considered weak.

Table 23 Relationship between intention to undertake hydrogen training and perceived enablers for training

Behavioural enablers	Pearson Correlation	Sig. (2-tailed)
Face to face training	.318**	0.000
Training sessions with regulator	.287**	0.000
A course with TAFE or other training provider (more than 1 week)	.253**	0.000
Intensive training	.243**	0.000
Training sessions with an association	.238**	0.000
Training with a supplier/manufacturer	.214**	0.000
A course with TAFE or other training provider (less than 1 week)	.207**	0.000
Daytime training	.205**	0.000
Onsite training (workplace training)	.200**	0.000
Evening training	.183**	0.000
Staggered training (sessions spread out over time)	.141**	0.000
Weekend training	.139**	0.000
Online training	.090**	0.006

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

3.6 TPB Model 1: Existing training behaviour

Using TPB with regards to existing training practices of gasfitters, the following relationships between actual behaviour, behavioural intention, attitudes, subjective norms and behavioural controls are proposed in Figure 11. The arrows shown in Figure 11 represent the direction of the hypothesised influence. For example, attitudes, subjective norms and behavioural controls influence behavioural intention and therefore the arrows show the direction from these latent variables to training behaviour.

Figure 11 TPB model for existing training behaviour

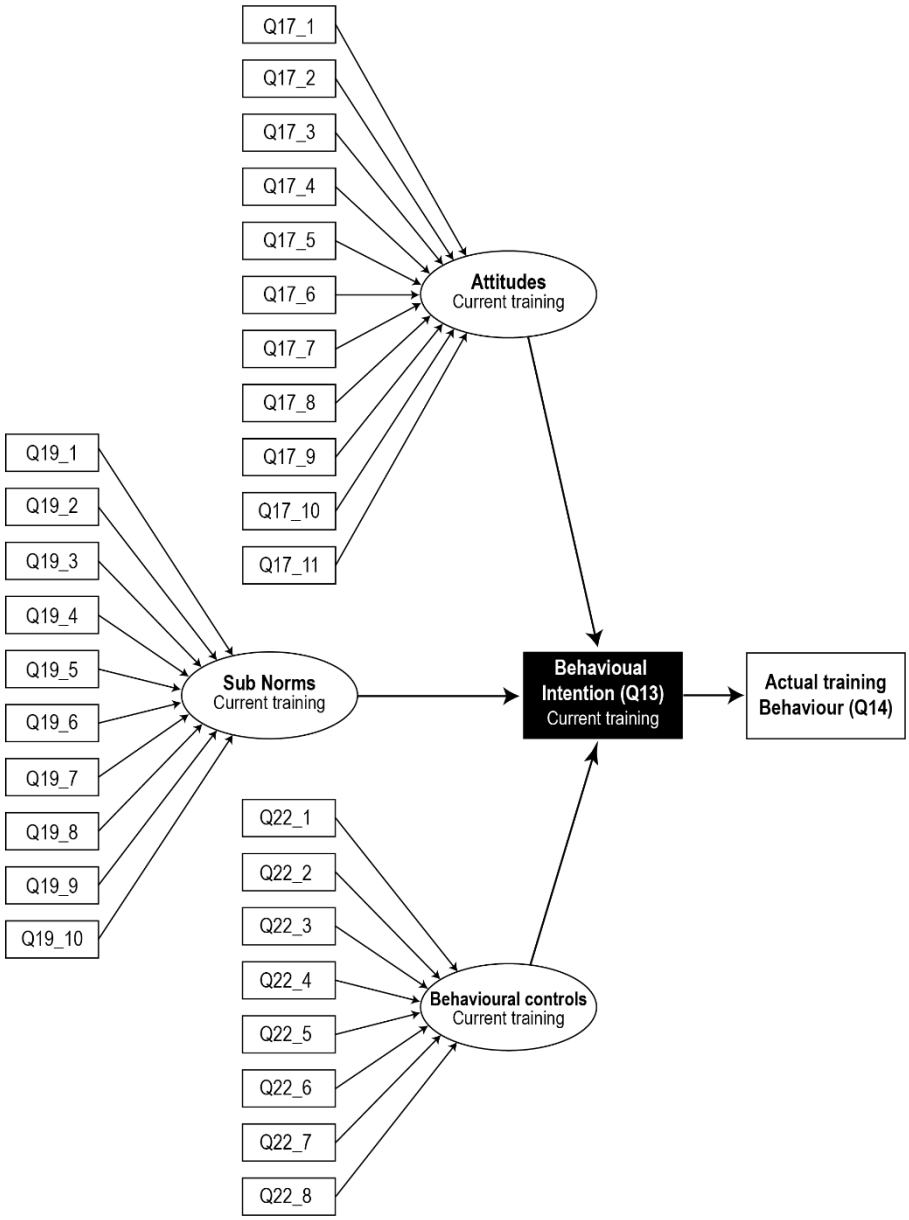


Figure legend:

Attitude items

Q17_1	The short to medium term competitiveness of the business I work in/own
Q17_2	The long-term viability of my plumbing/gasfitting trade
Q17_3	The quality of the work I undertake
Q17_4	Providing advice to customers about products and services
Q17_5	Providing assistance or advice to colleagues about products and practices
Q17_6	Helping me meet my trade licensing requirements
Q17_7	Helping me to meet the requirements of the technical standards
Q17_8	Adding to my skills/knowledge in plumbing/gasfitting
Q17_9	Increasing my career opportunities
Q17_10	Increasing my skills/knowledge to ensure safe work practices for customers
Q17_11	Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)

Subjective norm items

Q19_1	Customer
Q19_2	Regulator
Q19_3	Colleagues/Peers
Q19_4	Friends

Q19_5	Family
Q19_6	Employer (if not self-employed)
Q19_7	Insurers
Q19_8	Suppliers/manufacturers
Q19_9	Associations for which I am a member of (e.g. Master Plumbers)
Q19_10	Unions
Behavioural control items	
Q22_1	Availability of training opportunities provided by TAFEs or other training organisations
Q22_2	Availability of training opportunities provided by associations (e.g Master Plumbers)
Q22_3	Availability of training opportunities provided by regulators
Q22_4	Availability of training opportunities provided by suppliers or manufacturers
Q22_5	Cost of training
Q22_6	Time taken by training
Q22_7	Licensing requirements
Q22_8	Travel distance for training

3.6.1 Construct reliabilities for Model 1: Existing training behaviour

Cronbach's alpha reliability tests were conducted to check the internal consistency of each SEM model to ensure the appropriateness of groupings of constructs (attitudes, subjective norms, behavioural controls) and actual training behaviour. Cronbach's alpha values were above 0.7 for all groupings indicating that the operational statements (i.e., Q17_1, Q17_2, Q17_3, and so on) are significantly related to the respective construct. As such, the operational statements included in the conceptual framework and their respective groupings are kept in the initial structural equation model (Jashapara, 2003). Table 24 presents the Cronbach's alpha results for Model 1: Existing training behaviour.

Table 24 Cronbach's alpha results for Model 1: Existing training behaviour

Construct	Alpha
Attitude	0.96
Sub norms	0.90
Behavioural Controls	0.88

3.6.2 Goodness of Fit indices

GOF measures are used to ascertain how well a model fits a given data set and how well it can indicate a future set of observations. The GOF measure results for the SEM TPB model 1 are shown in Table 25. The final model passed all the GOF requirements with 5 rounds of revision of the interrelationship paths and adding error paths (Arbuckle & Wothke, 1999). The ratio for $\chi 2/df$ is 4.11 and the GFI is 0.88 which indicate that the final model provides a good fit to the data. The RMSEA value is 0.07 at $p<0.05$. A RMSEA value lower than 0.10 at $p<0.05$ represents the significance of the hypothesised relationships in the final model (Molenaar et al., 2000).

Table 25 Goodness-of-fit (GOF) measures: Recommended levels and results for TPB Model 1

Goodness-of-fit (GOF) measure	Recommended acceptance thresholds of the GOF indices	Model's GOF results	
		Initial	Final
Goodness-of-fit index (GFI)	0 (No fit) to 1 (Perfect fit)	0.74	0.88
RMSEA	<0.05 indicates very good fit – threshold level is 0.10	0.10	0.07
Tucker-Lewis index (TLI)	0 (No fit) to 1 (Perfect fit)	0.78	0.90
Normal fit index (NFI)	0 (No fit) to 1 (Perfect fit)	0.77	0.89

Source: Table format adopted from Molenaar et al. (2000)

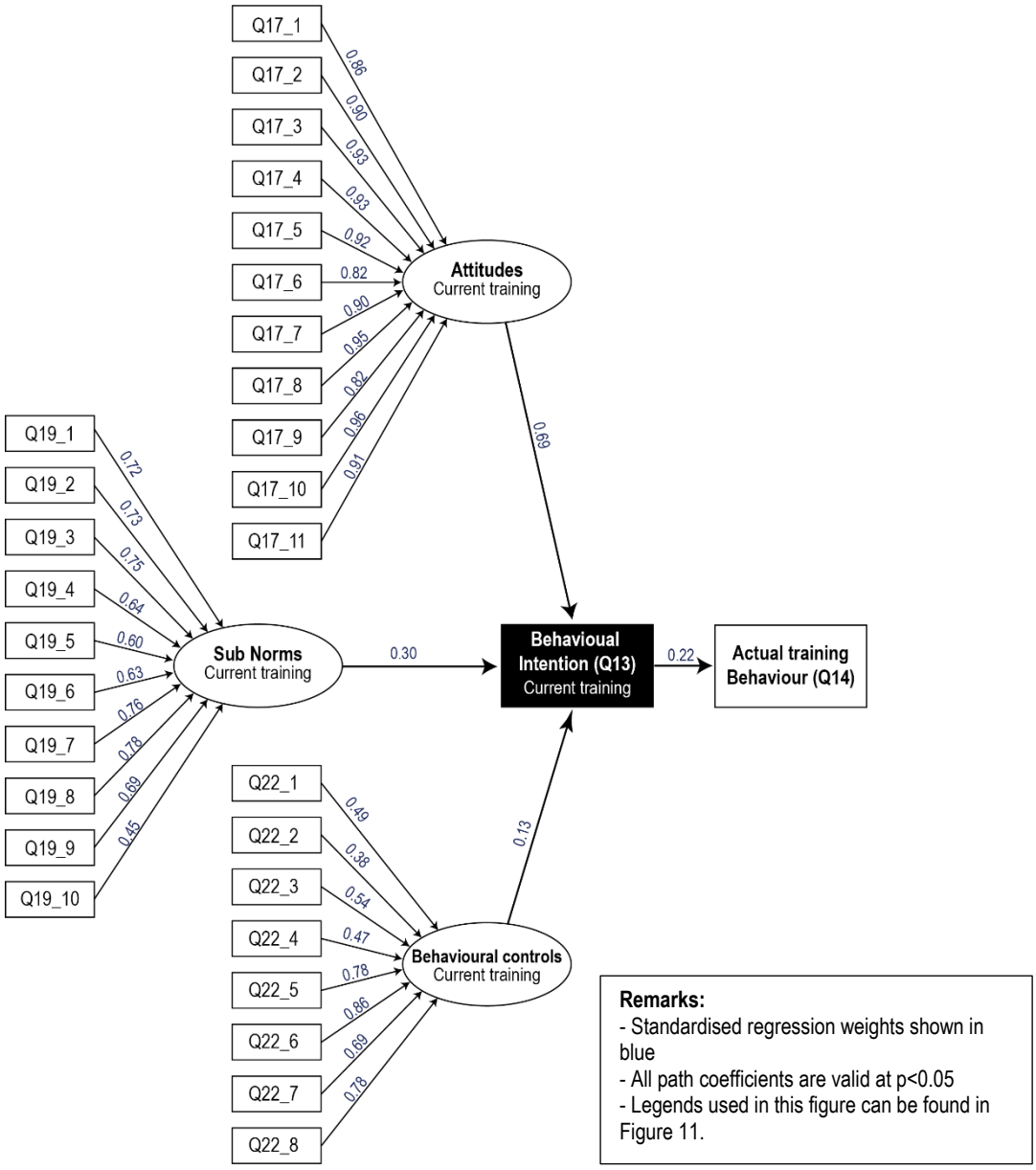
3.6.3 The final model: Existing training behaviour

All of the variables (from the operational statements), latent variables (attitudes, subjective norms and behavioural controls) and relationship paths were retained in the final model for existing training behaviour. The final SEM model for existing training behaviour is shown below in Figure 12. The numbers added to the conceptual model in Figure 12 show the standardised regression weights for the relationships between variables, latent variables and actual behaviour.

The results of the SEM indicate that *respondent attitudes towards training have a direct positive impact on their intention to undertake training* (β = 0.69). All behavioural belief operational statements were positively related to the attitudes; however, ‘adding to my skills/knowledge in plumbing/gasfitting’ (β = 0.95) and ‘increasing my skills/knowledge to ensure safe work practices for customers’ (β = 0.96) had the greatest impact. The impact of subjective norms on behavioural intention was significantly less than attitudes with a standard regression weight of 0.30. Sub norm variables including the customer (β = 0.72), regulator (β = 0.73), colleagues/peers (β = 0.75), insurers (β = 0.76), and suppliers/manufacturers (β = 0.78), had the greatest impact and unions (β = 0.10) had the least. The standard regression weight between behavioural controls and intention to undertake training was 0.13, the lowest weight between the latent variables and behavioural intention indicating that this had the least impact on intentions. Behavioural control variables differed in weighting with cost of training (β = 0.78), time taken by training (β = 0.86) and travel distance for training (β = 0.78) having the greatest influence on behavioural controls and availability of training opportunities provided by associations having least at 0.38. This suggests that these behavioural control variables were more likely to enable respondents to undertake training than the other variables, including opportunities provided by associations.

Overall Model 1 indicates that for plumber/gasfitters, attitudes towards training are more influential over training intention than subjective norms (what others think about their training practices), and also behavioural controls. According to the model, behavioural intention has a week positive relationship to actual training however this regression weighting must be interpreted with consideration of the Likert scale used for the associated survey question. For this survey question, 'sometimes (3 to 6 times in the past three year period)' was coded at 2 and the results had a mean of 2.34 (SD 1.041) which may be interpreted as low on a 5 point Likert Scale. However, depending on the type of training undertaken and industry changes necessitating training in the last three years, 3 to 6 times in the past three year period may be deemed enough training to have undertaken to keep up to date with practice requirements and indicative of sufficient training practices.

Figure 12 TPB Model 1: Existing training behaviour with path analysis results



3.7 TPB Model 2: Future hydrogen training behaviour

Using TPB with regards to future hydrogen training behaviour of gasfitters, the following relationships between actual behaviour, behavioural intention, attitudes, subjective norms and behavioural controls are proposed in Figure 13. The arrows shown in Figure 13 represent the direction of the hypothesised influence. For example, attitudes, subjective norms and behavioural controls influence behavioural intention and therefore the arrows show the direction from these latent variables to training behaviour.

Here, the operational statements for attitudes and the operational statements for subjective norms are the same as in Model 1, however the behavioural control items differ because there is currently no relevant, broadly available hydrogen training for respondents to consider when answering questions about controls on their ability to undertake training. Instead, preferences for hydrogen training delivery have been used here to indicate what delivery mode of training would most influence intention to undertake hydrogen training.

Figure 13 TPB model for future hydrogen training behaviour

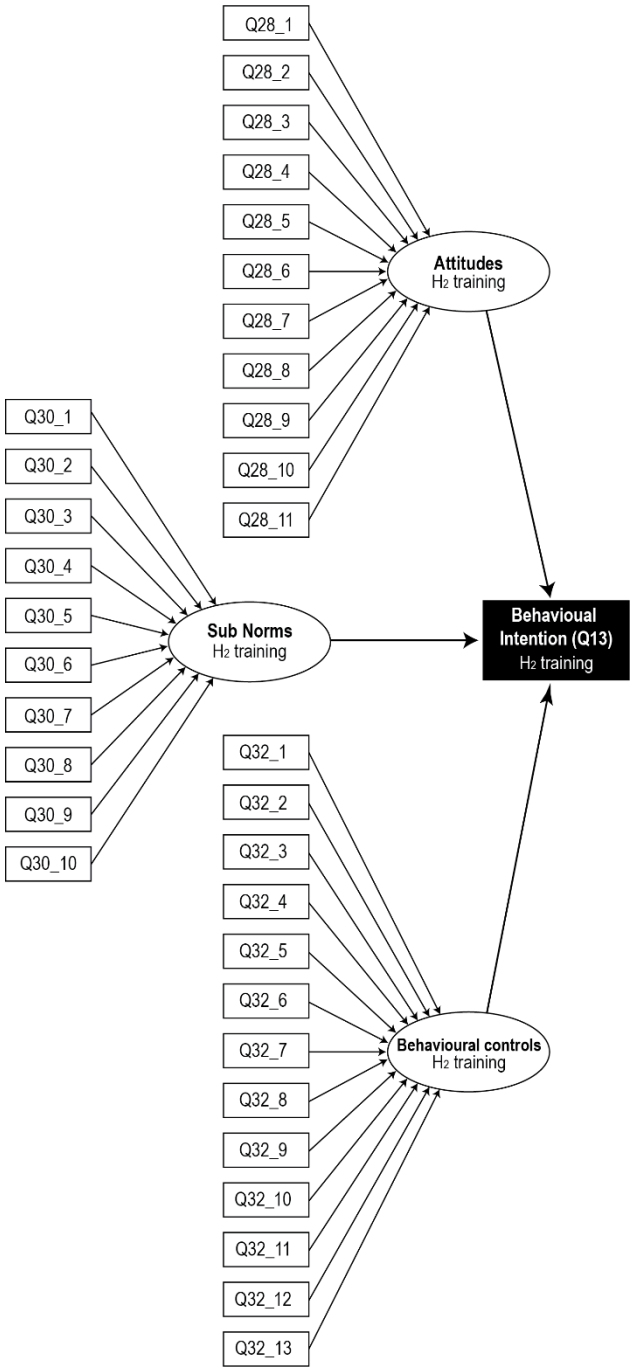


Figure legend:

Attitude items	
Q28_1	The short to medium term competitiveness of the business I work in/own
Q28_2	The long-term viability of my plumbing/gasfitting trade
Q28_3	The quality of the work I undertake
Q28_4	Providing advice to customers about products and services
Q28_5	Providing assistance or advice to colleagues about products and practices
Q28_6	Helping me meet my trade licensing requirements
Q28_7	Helping me to meet the requirements of the technical standards
Q28_8	Adding to my skills/knowledge in plumbing/gasfitting
Q28_9	Increasing my career opportunities
Q28_10	Increasing my skills/knowledge to ensure safe work practices for customers
Q28_11	Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)

Subjective norm items

Q30_1	Customer
Q30_2	Regulator
Q30_3	Colleagues/Peers
Q30_4	Friends
Q30_5	Family
Q30_6	Employer (if not self-employed)
Q30_7	Insurers
Q30_8	Suppliers/manufacturers
Q30_9	Associations for which I am a member of (e.g. Master Plumbers)
Q30_10	Unions

Behavioural control items

Q32_1	A course with TAFE or other training provider (less than 1 week)
Q32_2	A course with TAFE or other training provider (more than 1 week)
Q32_3	Onsite training (workplace training)
Q32_4	Online training
Q32_5	Face to face training
Q32_6	Training sessions with regulator
Q32_7	Training sessions with an association
Q32_8	Training with a supplier/manufacturer
Q32_9	Evening training
Q32_10	Daytime training
Q32_11	Weekend training
Q32_12	Intensive training
Q32_13	Staggered training (sessions spread out over time)

3.7.1 Construct reliabilities for Model 2: Future hydrogen training behaviour

Cronbach's alpha reliability tests were conducted to check the internal consistency of each SEM model to ensure the appropriateness of groupings of constructs (attitudes, subjective norms, behavioural controls) and intention to undertake training in hydrogen in the future. Cronbach's alpha values were above 0.7 for all groupings indicating that the operational statements (i.e., Q28_1, Q28_2, Q28_3, and so on) are significantly related to the respective construct. As such, the operational statements included in the conceptual framework and their respective groupings are kept in the initial structural equation model (Jashapara, 2003). Table 26 presents the Cronbach's alpha results for Model 2: Hydrogen training behaviour.

Table 26 Cronbach's alpha results for Model 2: Hydrogen training behaviour

Construct	Alpha
Attitude	0.94
Sub Norms	0.90
Behavioural Controls	0.80

3.7.2 Goodness of Fit indices

GOF measures are used to ascertain how well a model fits a given data set and how well it can indicate a future set of observations. The GOF measure results for the SEM TPB model 2 are shown in Table 25. The final model passed all the GOF requirements with 3 rounds of revision of the interrelationship paths and adding error paths (Arbuckle & Wothke, 1999). The ratio for $\chi 2/df$ is 4.31 and the GFI is 0.83 which indicate that the final model provides a good fit to the data. The RMSEA value is 0.07 at $p<0.05$. A RMSEA value lower than 0.10 at $p<0.05$ represents the significance of the hypothesised relationships in the final model (Molenaar et al., 2000).

Table 27 Goodness-of-fit (GOF) measures: Recommended levels and results for TPB Model 2

Goodness-of-fit (GOF) measure	Recommended acceptance thresholds of the GOF indices	Model's GOF results	
		Initial	Final
Goodness-of-fit index (GFI)	0 (No fit) to 1 (Perfect fit)	0.76	0.83
RMSEA	<0.05 indicates very good fit – threshold level is 0.10	0.09	0.07
Tucker-Lewis index (TLI)	0 (No fit) to 1 (Perfect fit)	0.76	0.86
Normal fit index (NFI)	0 (No fit) to 1 (Perfect fit)	0.75	0.84

Source: Table format adopted from Molenaar et al. (2000)

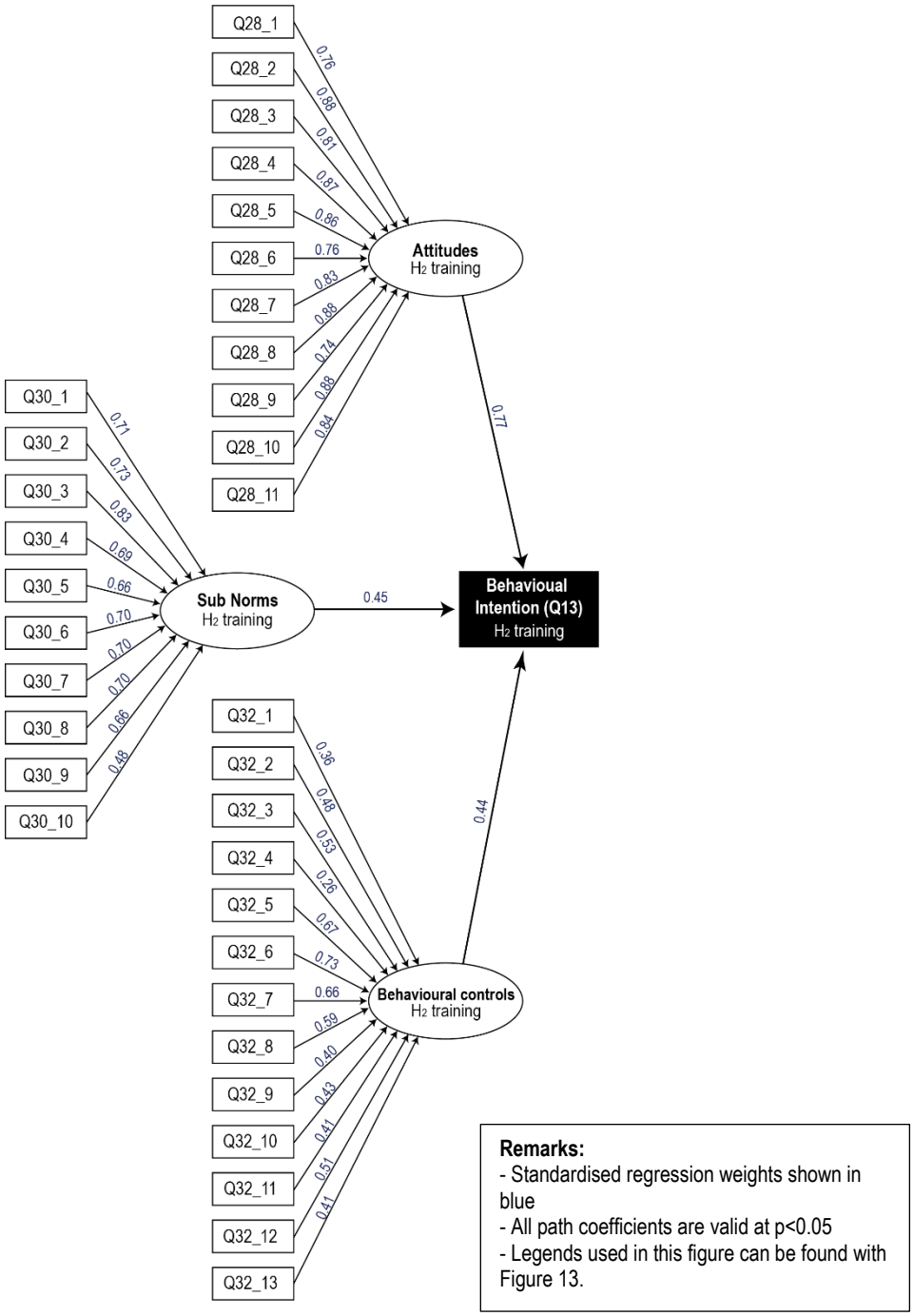
3.7.3 The final model: Future hydrogen training behaviour

All of the variables (from the operational statements), latent variables (attitudes, subjective norms and behavioural controls) and relationship paths were retained in the final model for existing training behaviour. The final SEM model for existing training behaviour is shown below in Figure 14. The numbers added to the conceptual model in Figure 14 show the standardised regression weights for the relationships between variables, latent variables and actual behaviour.

The results of the SEM indicate that respondent attitudes towards hydrogen training have a direct positive impact on their intention to undertake hydrogen training (β = 0.77). All behavioural belief operational statements were positively related to the attitudes. The impact of subjective norms on behavioural intention was less than attitudes with a standard regression weight of 0.45. Sub norm variables including the regulator (β = 0.73), colleagues/peers (β = 0.83) had the greatest impact and unions (β = 0.48) had the least. The standard regression weight between behavioural controls and intention to undertake training had a similar standard regression weight as subjective norms (β = 0.44). Behavioural control variables differed in weighting with training with the regulator having the greatest influence (β = 0.73) and availability a course with TAFE or other training provider (less than 1 week) having least at 0.38.

Overall Model 2 suggests that for plumber/gasfitters, attitudes towards hydrogen training are more influential over hydrogen training intention than subjective norms (what others think about their training for hydrogen), and also behavioural controls.

Figure 14 TPB Model 2: Future hydrogen training behaviour with path analysis results



3.8 Qualitative results

401 qualitative comments were provided by respondents when asked if they had any comments they would like to share with industry and government stakeholders on the transition to hydrogen and/or training/upskilling preferences (Question 34). These comments were analysed using NVivo 12 Pro. The comments were coded based on key themes and frequencies were counted.

Table 28 presents these themes and frequency count. Some comments were coded for more than one theme.

Table 28 Key themes and frequency count

Themes	Frequency count
Needs	
More communication and information about hydrogen, implications for gasfitting and timelines	69
Adequate skills and associated training	63
Sufficient regulation	13
Appropriate licensing structures	13
Adequately qualified trainers and training facilities	11
Positive comments	
Hydrogen presents an upskilling or learning opportunity	42
Quicker transition required (i.e.. 'the quicker the better')	40
General positive comment (i.e. 'It is a step in the right direction')	21
Interested in hydrogen generally	15
Hydrogen presents a business opportunity	11
Hydrogen is important to compete with moves to 100 per cent electric homes	8
Concerns	
Concerns about cost of training or costs to consumers	40
Sceptical about commercial viability of hydrogen	21
Concerns about safety	20

As shown in

Table 28, respondents made comments on a variety of topics that they felt were important. A large number of comments related to the respondents' perceived needs during a transition to hydrogen which included ensuring that those undertaking the hydrogen work were adequately trained to do the work. This was also dependent on having appropriately qualified and experienced trainers and facilities for hydrogen training. Not directly related to training were comments made about the need for effective regulatory structures and licensing systems. A number of respondents mentioned that they felt gasfitting work was currently not regulated adequately in their respective jurisdictions and that hydrogen would need to be better regulated. The need for consistency of training and licensing requirements was also noted by a number of respondents.

The large majority of respondent comments were positive towards hydrogen. A number of respondents felt that hydrogen presented business opportunities and that it is the future of the industry. Others felt that it was a good opportunity to upskill or continue to develop their expertise. There were also general positive comments made about the transition being good or beneficial, and a number of comments expressing general interest in hydrogen and desire to learn more about the potential for hydrogen. Forty comments expressed the desire to see the transition and associated training happen sooner and a small number of comments discussed this need in the context of the gas industry being able to compete with moves to 100 per cent electric homes.

Within the comments, there were also some that expressed concerns about the safety of hydrogen and also the cost of potential training or the cost to consumers more broadly from a transition from natural gas to hydrogen. Some respondents expressed their broad scepticism for the viability of a transition from natural gas to hydrogen. These comments further underscore the need for clear communication and information about hydrogen and transition plans with stakeholders to address such concerns amongst gasfitters.

There were 74 comments about the type of training respondents would prefer or felt was suitable for hydrogen. Themes within these comments were coded and are shown in Table 29. Some comments were coded for more than one theme.

Table 29 Type of training preferred by respondents

Themes regarding training preferences	Frequency count
Free or affordable/subsidised	21
Online	12
TAFE	10
Hands on/face-to-face/practical training	7
Concise and relevant	7
Availability in rural areas	8
Flexible	7
Easily accessible	4
After hours	3
Daytime hours	2
Linked to CPD	2
Training provided by utility company	1

A key theme for the comments coded in Table 29 was a desire for hydrogen training to be free or at least affordable through subsidisation of courses. There were a mix of preferences regarding online or face to face training with some noting both would be suitable for them. A number of comments specifically noted TAFE as being the best provider of training, followed by comments about the training needing to be concise and relevant or to the point. Availability in rural areas was noted as important by 8 respondents who felt that travel time to courses for themselves or their staff presented a key challenge for accessing future hydrogen training. Some of these respondents felt that online training would be more suitable for these reasons. Flexibility and accessibility were also themes noted by some respondents.

4. Conclusion

Plumber/gasfitters' intention to undertake training is driven by their attitudes towards training and associated perceived benefits of training, but not substantially by their perceived subjective norms or behavioural controls. This suggests that plumber/gasfitters are independently interested in undertaking training because of a variety of benefits this provides, in particular, developing their skills and knowledge for their gasfitting practice and using their skills and knowledge to undertake safe work that protects their customers. The results also showed that plumber/gasfitters surveyed have undertaken some form of training between 3 to 6 times in the past three years.

Given the key role that attitudes and associated behavioural beliefs play in gasfitters intention to undertake training, clear identification and communication of the value of training is most important for supporting any subsequent training behaviour. In particular, the value of training must be aligned with supporting plumber/gasfitters to develop skills and knowledge for their practice and using their skills and knowledge to undertake safe work that protects their customers.

While, for most gasfitters, subjective norms and behavioural controls did not substantially influence behavioural intention for current training, these cannot be ignored when our desire is to reach as many gas fitters as possible. Suppliers/manufacturers, insurers, colleagues/peers, regulators and customers are all stakeholders whose encouragement to undertake training was felt by plumbers and gas fitters. The research shows that gasfitters also learn from a similar variety of stakeholders including regulators, employers, peers, colleagues, manufacturers/suppliers and associations. As a result, these stakeholders are critical in shaping plumber/gasfitters learning and encouraging further training practice. These stakeholders must be aware of and on board with the development of any training to support its uptake amongst practitioners.

Furthermore, accessibility and costs are also somewhat influential in training behaviour and are therefore a key part of enabling training to be undertaken. When designing training, consideration should be given to when and where this training is delivered and its affordability. If training is not a mandatory license requirement, these factors are critical to ensuring maximum uptake of training. If training is mandatory, these factors are vital in the acceptance by the industry of any training programs.

Respondents also expressed a strong positive attitude towards future hydrogen training however they currently have limited awareness of hydrogen and associated industry plans. The research result indicates that plumbers and gasfitters perceived hydrogen as a fuel that would ensure the ongoing sustainability of their trade. As such, hydrogen training needs to be developed and communicated to highlight the role hydrogen plays in the viability of plumbing/gasfitting and that the associated skills and knowledge are vital to future practice. A second value ascribed to hydrogen training was the need for new skills in order to work safely with hydrogen. This further emphasises the need for training to support future gas fitting practice and the safety of that practice for customers.

While, for most gasfitters, subjective norms did not substantially influence behavioural intention to train for hydrogen in the future, participants did identify colleagues and/or peers and the regulator as providing positive encouragement to support future hydrogen training. The perceived support of colleagues and peers in undertaking hydrogen training indicates a plumbing/gasfitting industry perception of the importance of hydrogen as a future fuel. The support from the regulator to undertake training suggests that respondents perceive the regulator as playing an important role in a transition to hydrogen. These stakeholders were also seen as sources of learning and information for plumber/gasfitters and, as such, ensuring these stakeholders are on board and informed about the hydrogen transition can support and capitalise on gasfitters strong positive attitudes towards training/upskilling for hydrogen.

Furthermore, while the model indicates that behavioural controls including training logistics do not strongly influence the undertaking of training, respondents recognised the importance of face-to-face training provided by the regulator and industry associations. As domestic hydrogen is new, plumber/gasfitters have identified a preference to be trained by key industry stakeholders that represent and regulate their practice. While TAFEs were recognised as appropriate training for established practices, the regulator and industry association's involvement in training for hydrogen was perceived as important for this new fuel source in the domestic setting. Consequently, any training programs offered by other providers will be more likely to be widely accepted if they are strongly supported by the regulator and industry associations.

Finally, respondents' limited awareness of hydrogen properties and transition plans indicates training is essential and has a dual purpose of upskilling to work with hydrogen and also educating the sector about the transition to hydrogen. In addition, there is merit in immediately commencing communications that increase awareness amongst gasfitters that there may be a transition to hydrogen, foreshadowing the future need for broad training/upskilling.

Based on these findings, to maximise uptake, it is essential that training programs for plumber/gasfitters generally:

- Communicate and include content regarding the value of training, particularly the development of skills and knowledge enabling safe work practices and customer safety;
- Ensure key influential stakeholders and information/learning sources such as suppliers/manufacturers, insurers and regulators are aware of and on board with the development of any training to be undertaken; and,
- Are easily accessible at an affordable price to gasfitters.

In addition to these considerations, with regards specifically to the uptake of hydrogen training, programs should:

- Be accompanied by communication that highlights the relationship between hydrogen and the long-term viability of the gasfitting trade to take advantage of the positive attitudes towards hydrogen training;
- Involve regulators and industry associations in the design and delivery of hydrogen training programs to ensure these key influential stakeholders show their support for training, even if training is delivered by TAFEs and other registered training organisations;
- Provide face-to-face hydrogen training opportunities; and,
- Be foreshadowed by a communication campaign that increases awareness about the transition to hydrogen as a future fuel to all key stakeholder groups.

To summarise, in the context of future hydrogen training, there is an opportunity to benefit from plumber/gasfitters strong positive attitudes towards such training by providing further information about the benefits of training and the transition and ensure that the variety of influential stakeholders that shape practice and ongoing learning are well informed about hydrogen plans and associated implications for gasfitting and training options. Such training options must be easily accessible and affordable for gasfitters in both regional and metropolitan areas.

5. Implications and recommendations for industry

While the successful transition of the gas network to future fuels is dependent on suitably trained gasfitters, the processes whereby gasfitter skills and competencies are managed lie outside the gas industry itself. This report (as with others produced by this project) provide important insights on how to ensure sufficient resources are available that the gas sector can draw on in discussions with regulators, the training sector and other key stakeholders.

6. Next steps and future works

This Interim Report 4 will be followed a final program report that summarises key findings from each of the 4 interim reports and make final recommendations for consideration by the gas industry.

7. Appendices

7.1 Question items/variables

Behavioural beliefs items	Subjective norm items	Behavioural controls items
• The short to medium term competitiveness of the business I work in/own • The long-term viability of my plumbing/gasfitting trade • The quality of the work I undertake • Providing advice to customers about products and services • Providing assistance or advice to colleagues about products and practices • Helping me meet my trade licensing requirements • Helping me to meet the requirements of the technical standards • Adding to my skills/knowledge in plumbing/gasfitting • Increasing my career opportunities • Increasing my skills/knowledge to ensure safe work practices for customers • Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	• Customer • Regulator • Colleagues/Peers • Friends • Family • Employer (if not self-employed) • Insurers • Suppliers/manufacturers • Associations for which I am a member of (e.g. Master Plumbers) • Unions	• Availability of training opportunities provided by TAFEs or other training organisations • Availability of training opportunities provided by associations (e.g Master Plumbers) • Availability of training opportunities provided by regulators • Availability of training opportunities provided by suppliers or manufacturers • Cost of training • Time taken by training • Licensing requirements • Travel distance for training
Training options for hydrogen question items		
• A course with TAFE or other training provider (less than 1 week) • A course with TAFE or other training provider (more than 1 week) • Onsite training (workplace training) • Online training • Face to face training • Training sessions with regulator • Training sessions with an association • Training with a supplier/manufacturer • Evening training • Daytime training • Weekend training • Intensive training • Staggered training (sessions spread out over time)		

7.2 Survey questions

Section	Questions	Response options
Introduction	Q1 Thank you for your interest in undertaking this survey. It should take about 10 minutes to complete. The questions will ask you about your plumbing and/or gasfitting trade, your experiences with training and your awareness and preferences for training with hydrogen in the future. You do not need any awareness of hydrogen to answer these questions. Your responses will help design future hydrogen training that meets the needs of trades people. Further information about the project can be downloaded by clicking here. If you have any questions about the project please contact Orana Sandri on (+61) 03 9925 2550 or at orana.sandri@rmit.edu.au	Descriptive text, no response required
Demographics	Q2 Which answer best describes the plumbing and gasfitting work you undertake in a typical year?	Only gasfitting/Only plumbing (other than gasfitting)/Mostly plumbing (other than gasfitting) with some gasfitting/Mostly gasfitting with some plumbing (other than gasfitting)/Half plumbing (other than gasfitting) and half gasfitting

	Q3 Approximately how many years have you been working as a plumber and/or gasfitter?	Less than one year/1-2 years/3-4 years/5-6 years/7-8 years/9-10 years/11-15 years/16-20 years/21-25 years/26-30 years/31+ years
	Q4 Approximately how many people work in the business you currently undertake most of your plumbing/gasfitting for?	1 person (myself)/2 people/1-4 people/5-19 people/20-199 people/200+ people
	Q5 What is your current role?	Owner/Manager/Employee/Apprentice
	Q6 Over the course of a year, where do you undertake your work? You can select more than one answer.	Multi-residential (apartments or large developments)/Single dwellings/Commercial (e.g. restaurants, offices)
	Q7 What type of gasfitting work are you currently licensed or registered to undertake? You can select more than one answer.	Not currently licensed for any gasfitting work/Type A appliance installation (natural gas)/Type A appliance servicing (natural gas)/LPG gasfitting (any)/Type B gasfitting (any)/Caravan and/or boat gasfitting (any)
	Q8 What state do you predominantly undertake your plumbing and/or gasfitting work in?	State/Territory
	Q9 Where is the majority of your work located?	Suburban/metropolitan/Regional/Both metropolitan and regional
	Q10 Which of the following qualifications have you obtained for your plumbing/gasfitting work? You can select more than one answer.	Certificate I in Plumbing Services/Certificate II in Plumbing/Certificate II in Drainage/Certificate III in Plumbing/Certificate III in Plumbing (Mechanical Services)/Certificate III in Roof Plumbing/Certificate III in Gas Fitting/Certificate IV in Plumbing and Services/Install, commission and service Type B gas appliances (single Unit of Competency)/Service Type A gas appliances (single Unit of Competency)/Other:
	Q11 What is your year of birth?	4 digit year
	Q12 What is your gender?	Male/female/other
TPB - Actual behaviour and behavioural intention questions: Current training practices	Q13 In the future, I intend to undertake additional training (for example a course or seminar) relevant to my plumbing/gas fitting work: (My plumbing/gasfitting work will be referred to as *my trade practice* for the remainder of the survey)	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q14 In the past three years, I have undertaken additional training relevant to my trade practice:	5-point scale: Not at all/rarely (1-2 times in the last 3 years)/sometimes (3-6 times in the last 3 years)/often (approx. monthly)/very often (approx. weekly)
TPB - Behavioural belief questions: Current training practices	Q15 I have a positive attitude towards undertaking additional training relevant to my trade practice:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q16 In the past, I have had positive experiences undertaking training relevant to my trade practice:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree

	Q17 Undertaking additional training relevant to my trade practice is beneficial for the following: Matrix table statements: (1)The short to medium term competitiveness of the business I work in/own (2) The long-term viability of my plumbing/gasfitting trade (3) The quality of the work I undertake (4) Providing advice to customers about products and services (5) Providing assistance or advice to colleagues about products and practices (6) Helping me meet my trade licensing requirements (7) Helping me to meet the requirements of the technical standards (8) Adding to my skills/knowledge in plumbing/gasfitting (9) Increasing my career opportunities (10) Increasing my skills/knowledge to ensure safe work practices for customers (11) Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
TPB - Subjective norms: Current training practices	Q18 The following people are influential on my trade practice: Matrix table statements: (1) Customer (2) Regulator (3) Colleagues/Peers (4) Friends (5) Family (6) Employer (if not self-employed) (7) Insurers (8) Suppliers/manufacturers (9) Associations for which I am a member of (e.g. Master Plumbers) (10) Unions	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q19 The following people will show their support/encouragement if I undertake further training relevant to my trade practice: Matrix table statements: (1) Customer (2) Regulator (3) Colleagues/Peers (4) Friends (5) Family (6) Employer (if not self-employed) (7) Insurers (8) Suppliers/manufacturers (9) Associations for which I am a member of (e.g. Master Plumbers) (10) Unions	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q20 The following people will discourage me from undertaking further training relevant to my work in my trade practice: Matrix table statements: (1) Customer (2) Regulator (3) Colleagues/Peers (4) Friends (5) Family (6) Employer (if not self-employed) (7) Insurers (8) Suppliers/manufacturers (9) Associations for which I am a member of (e.g. Master Plumbers) (10) Unions	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
TPB - Behavioural controls: Current training practices	Q21 Undertaking further training relevant to my trade practice is up to me:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q22 The following factors enable me to undertake further training relevant to my trade practice: Matrix table statements: (1) Availability of training opportunities provided by TAFEs or other training organisations (2) Availability of training opportunities provided by associations (e.g Master Plumbers) (3) Availability of training opportunities provided by regulators (4) Availability of training opportunities provided by suppliers or manufacturers (5) Cost of training (6) Time taken by training (7) Licensing requirements (8) Travel distance for training	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q23 The following factors prevent/discourage me from undertaking further training relevant to my trade practice: Matrix table statements: (1) Availability of training opportunities provided by TAFEs or other training organisations (2) Availability of training opportunities provided by associations (e.g Master Plumbers) (3) Availability of training opportunities provided by regulators (4) Availability of training opportunities provided by suppliers or manufacturers (5) Cost of training (6) Time taken by training (7) Licensing requirements (8) Travel distance for training	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree

Sources of learning	Q24 For my trade practice, I get information/learn from the following sources: Matrix table statements: (1) Customers (2) Suppliers (3) Manufacturers (4) Regulatory authorities (5) Peers/informal networks outside of my business (6) Employer (7) Colleagues in my business (not apprentices) (8) Apprentices (9) YouTube (10) Social media (11) Associations (e.g. Master Plumbers) (12) Websites (13) TAFE providers (14) Family (15) Lawyers (16) Accountants (17) Banks (18) Insurance companies (19) Unions	5-point scale: Never/sometimes/about half the time/most of the time/always
Knowledge of hydrogen	Q25 I am confident in describing the properties/characteristics of hydrogen gas to others:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q26 I could describe Australia's plans for a future hydrogen industry to others:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
Hydrogen description	Q27 Over the next decade, the gas industry and governments plan to substitute natural gas with hydrogen as a low carbon fuel for Australian households. Appropriately skilled gas fitters are critical to the transition to hydrogen as a future fuel within the domestic energy market. If 100 per cent hydrogen is introduced into the domestic gas network, existing plumbers/gas fitters will need to upskill to work safely with hydrogen and associated appliances. With this understanding, the following questions ask you about your preferences for undertaking further training to expand on your skills/knowledge in plumbing/gas fitting for working with hydrogen. In this study, hydrogen training means undertaking a course to develop skills and knowledge to work with hydrogen.	Descriptive text, no response required
TPB - Behavioural belief: Hydrogen upskilling	Q28 If hydrogen training is available, undertaking such training will be beneficial to: Matrix table statements: (1)The short to medium term competitiveness of the business I work in/own (2) The long-term viability of my plumbing/gasfitting trade (3) The quality of the work I undertake (4) Providing advice to customers about products and services (5) Providing assistance or advice to colleagues about products and practices (6) Helping me meet my trade licensing requirements (7) Helping me to meet the requirements of the technical standards (8) Adding to my skills/knowledge in plumbing/gasfitting (9) Increasing my career opportunities (10) Increasing my skills/knowledge to ensure safe work practices for customers (11) Skills/knowledge that reduce the environmental impacts associated plumbing and/or gasfitting work (e.g. water/energy use, carbon emissions)	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
TPB - Behavioural intention: Hydrogen upskilling	Q29 If hydrogen training is available, I will undertake such training:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
TPB – Subjective norms: Hydrogen upskilling	Q30 If hydrogen training is available, the following people will show their support/encouragement for me to undertake such training: Matrix table statements: (1) Customer (2) Regulator (3) Colleagues/Peers (4) Friends (5) Family (6) Employer (if not self-employed) (7) Insurers (8) Suppliers/manufacturers (9) Associations for which I am a member of (e.g. Master Plumbers) (10) Unions	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
	Q31 If hydrogen training is available, the following people will discourage me from undertaking such training: Matrix table statements: (1) Customer (2) Regulator (3) Colleagues/Peers (4) Friends (5) Family (6) Employer (if not self-employed) (7) Insurers (8) Suppliers/manufacturers (9) Associations for which I am a member of (e.g. Master Plumbers) (10) Unions	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree

Learning preferences for hydrogen upskilling	Q32 If hydrogen training is available, the following forms of delivery will more likely enable me to participate in such training: Matrix table statements: (1) A course with TAFE or other training provider (less than 1 week) (2) A course with TAFE or other training provider (more than 1 week) (3) Onsite training (workplace training) (4) Online training (5) Face to face training (6) Training sessions with regulator (7) Training sessions with an association (8) Training with a supplier/manufacturer (9) Evening training (10) Daytime training (11) Weekend training (12) Intensive training (13) Staggered training (sessions spread out over time)	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
View of hydrogen transition	Q33 A transition to hydrogen will benefit the plumbing/gasfitting industry:	5-point agreement scale: Strongly disagree/somewhat disagree/neither agree nor disagree/somewhat agree/ strongly agree
Other comments	Q34 Do you have any comments you would like to share with industry and government stakeholders on the transition to hydrogen and/or training/upskilling preferences?	Open qualitative text

7.3 One-way ANOVA results tables

7.3.1 One-way ANOVA: Respondent Age

#	Question	18-30	31-40	41-50	51-60	61-70	> 70	F value	ρ
13	Intention to undertake training in the future	4.39	4.29	4.23	3.98	3.93	3.83	4.851	<.001*
14	Actual training practices over the past three years	2.64	2.43	2.40	2.36	2.11	1.94	4.584	<.001*
17_9	Benefits of training: Increasing my career opportunities	4.55	4.41	4.15	3.89	3.78	3.94	11.731	<.001*
18_1	People influential on trades practice: Customer	3.76	3.97	4.06	4.10	4.13	4.29	2.291	.044*
18_4	People influential on trades practice: Friends	2.93	3.13	2.92	3.02	3.29	3.21	3.128	.008*
22_4	Positive behavioural controls: Availability of training opportunities provided by suppliers or manufacturers	3.72	3.92	3.90	3.95	4.15	4.23	2.811	.016*
22_7	Positive behavioural controls: Licensing requirements	3.91	4.11	4.06	4.19	4.23	4.53	2.647	.022*
23_1	Negative behavioural controls: Availability of training opportunities provided by TAFEs or other training organisations	3.57	3.32	3.47	3.31	3.00	3.03	3.234	.007*
23_2	Negative behavioural controls: Availability of training opportunities provided by associations	3.21	3.16	3.36	3.17	2.97	2.83	2.261	.047*
23_5	Negative behavioural controls: Cost	3.68	3.72	3.68	3.60	3.32	3.17	3.251	.006*
23_6	Negative behavioural controls: Time	3.66	3.67	3.65	3.47	3.23	3.06	4.242	.001*
23_7	Negative behavioural controls: Licensing requirements	3.47	3.25	3.32	3.09	3.02	2.57	3.659	.003*
23_8	Negative behavioural controls: Distance	3.59	3.59	3.68	3.55	3.30	3.09	2.954	.012*
24_3	Knowledge sources: Manufacturers	2.68	2.88	2.77	2.95	3.08	2.97	2.322	.041*
24_4	Knowledge sources: Regulatory authorities	3.17	3.17	3.08	3.34	3.37	3.74	2.778	.017*
24_6	Knowledge sources: Employer	3.24	3.27	2.87	2.73	2.96	2.45	4.329	.001*
24_7	Knowledge sources: Colleagues in my business	3.00	3.21	2.89	2.77	2.82	2.63	3.571	.003*
24_11	Knowledge sources: Associations	2.27	2.32	2.22	2.43	2.54	2.76	2.306	.043*
24_12	Knowledge sources: Websites	2.42	2.57	2.44	2.66	2.77	2.81	2.445	.033*
24_13	Knowledge sources: TAFE providers	2.77	2.82	2.30	2.43	2.67	2.22	4.817	<.001*
24_14	Knowledge sources: Family	1.55	1.75	1.48	1.39	1.58	1.40	4.217	.001*
25	Confidence in describing the properties/characteristics of hydrogen gas to others	2.45	2.81	2.87	3.11	3.06	3.38	4.077	.001*

7.3.2 One-way ANOVA: Respondent State/Territory

#	Question	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	F value	ρ
13	Intention to undertake training in the future	4.11	3.92	3.00	4.24	4.28	4.64	4.11	4.17	3.854	<.001*
14	Actual training practices over the past three years	2.33	2.14	2.00	2.53	2.37	3.34	2.57	2.15	10.815	<.001*
17_6	Behavioural beliefs about additional training: Helping me meet my trade licensing requirements	4.18	4.03	3.00	4.29	4.08	4.56	4.27	4.18	2.513	.015*
19_2	Positive subjective norms: Regulator	4.11	4.04	3.00	4.15	4.19	4.56	3.97	3.93	2.376	.021*
20_2	Negative subjective norms: Regulator	1.60	1.74	3.00	1.97	1.57	1.57	1.79	1.83	2.020	.050*
22_2	Positive behavioural controls: Availability of training opportunities provided by associations (e.g Master Plumbers)	4.15	3.67	3.00	3.97	3.79	4.07	4.04	3.84	2.981	.004*

23_1	Negative behavioural controls: Availability of training opportunities provided by TAFEs or other training organisations	2.96	3.16	3.00	3.13	3.33	3.78	3.74	3.40	3.954	<.00*1
23_2	Negative behavioural controls: Availability of training opportunities provided by associations (e.g Master Plumbers)	2.97	3.08	3.00	3.02	3.09	3.56	3.50	3.19	2.427	.018*
24_7	Knowledge sources: Colleagues in my business (not apprentices)	3.31	2.88	3.00	2.91	3.11	2.65	2.96	2.69	2.625	.011*
24_10	Knowledge sources: Social media	1.71	1.54	3.00	1.60	1.64	1.71	1.67	1.39	2.175	.034*
24_11	Knowledge sources: Associations (e.g. Master Plumbers)	2.54	2.22	3.00	2.56	2.43	2.29	2.65	2.25	2.740	.008*
24_19	Knowledge sources: Unions	1.49	1.42	3.00	1.43	1.25	1.19	1.56	1.31	2.068	.044*
29	Intention to undertake hydrogen training	4.69	4.52	4.00	4.63	4.73	4.86	4.60	4.66	2.334	.023*

Australian Capital Territory = ACT, New South Wales = NSW, Northern Territory = NT, Queensland = QLD, South Australia = SA, Tasmania = TAS, Victoria = VIC, Western Australia - WA

7.3.3 One-way ANOVA: Respondent Role

#	Question	Owner	Manager	Employee	Apprentice	F value	ρ
14	Actual training practices over the past three years	2.27	2.62	2.39	2.75	4.331	.005*
17_9	Behavioural beliefs about additional training: Increasing my career opportunities	4.01	4.14	4.24	4.88	4.157	.006*
18_1	People influential on trades practice: Customer	4.17	3.96	3.83	3.75	7.548	<.001*
18_3	People influential on trades practice: Colleagues/Peers	3.93	3.99	4.08	4.75	3.449	.016*
18_6	People influential on trades practice: Employer (if not self-employed	3.64	4.29	4.16	4.63	25.788	<.001*
18_10	People influential on trades practice: Unions	2.50	2.61	2.88	3.63	7.726	<.001*
19_1	Positive subjective norms: Customer	3.75	3.54	3.49	3.63	3.618	.013*
19_3	Positive subjective norms: Colleagues/Peers	3.78	3.90	3.95	4.75	4.371	.005*
19_4	Positive subjective norms: Friends	3.38	3.24	3.45	4.43	3.269	.021*
19_5	Positive subjective norms: Family	3.53	3.42	3.66	4.50	3.410	.017*
19_6	Positive subjective norms: Employer (if not self-employed)	3.67	4.28	4.18	4.38	21.975	<.001*
19_10	Positive subjective norms: Unions	2.74	2.78	3.01	3.63	4.338	.005*
20_1	Negative subjective norms: Customer	1.81	1.97	2.00	3.00	5.560	<.001*
20_6	Negative subjective norms: Employer (if not self-employed)	1.92	1.69	1.90	2.75	3.121	.025*
20_7	Negative subjective norms: Insurers	1.89	2.04	2.01	3.00	3.926	.008*
20_8	Negative subjective norms: Suppliers/manufacturers	1.88	1.90	2.00	3.00	3.986	.008*
20_9	Negative subjective norms: Associations for which I am a member of (e.g. Master Plumbers)	1.89	1.94	2.04	2.88	3.562	.014*
24_2	Knowledge sources: Suppliers	2.75	2.56	2.60	3.25	2.783	.040*
24_5	Knowledge sources: Peers/informal networks outside of my business	2.85	2.78	2.81	4.00	2.876	.035*
24_6	Knowledge sources: Employer	2.87	3.12	3.00	4.38	4.071	.007*
24_8	Knowledge sources: Apprentices	1.79	1.69	1.72	2.75	3.910	.009*
24_10	Knowledge sources: Social media	1.61	1.49	1.49	2.50	4.677	.003*
24_11	Knowledge sources: Associations (e.g. Master Plumbers)	2.43	2.45	2.19	2.75	2.894	.034*
24_12	Knowledge sources: Websites	2.58	2.68	2.59	2.75	0.314	.816*
24_13	Knowledge sources: TAFE providers	2.55	2.59	2.51	4.25	4.737	.003*
24_14	Knowledge sources: Family	1.51	1.48	1.56	2.50	3.690	.012*
24_15	Knowledge sources: Lawyers	1.39	1.35	1.18	1.88	5.472	<.001*
24_16	Knowledge sources: Accountants	1.60	1.41	1.27	1.75	9.252	<.001*
24_17	Knowledge sources: Banks	1.33	1.25	1.14	1.88	6.713	<.001*
24_18	Knowledge sources: Insurance companies	1.53	1.45	1.25	1.75	7.080	<.001*
24_19	Knowledge sources: Unions	1.30	1.44	1.56	2.13	7.134	<.001*
25	Confidence in describing the properties/characteristics of hydrogen gas to others	3.05	2.86	2.79	2.38	2.883	.035*
26	Ability to describe Australia's plans for a future hydrogen industry to others	2.79	2.65	2.46	2.13	4.071	.007*
28_9	Behavioural beliefs about hydrogen training: Increasing my career opportunities	4.29	4.37	4.46	5.00	3.193	.023*
30_1	Positive subjective norms for hydrogen training: Customer	3.70	3.48	3.34	3.75	5.931	<.001*
30_5	Positive subjective norms for hydrogen training: Family	3.62	3.44	3.57	4.50	2.402	.066*
30_6	Positive subjective norms for hydrogen training: Employer (if not self-employed)	3.83	4.42	4.23	4.38	14.162	<.001*
30_8	Positive subjective norms for hydrogen training: Suppliers/manufacturers	4.05	3.85	3.77	4.00	5.037	.002*
30_10	Positive subjective norms for hydrogen training: Unions	2.91	2.89	3.20	4.00	4.841	.002*

31_1	Negative subjective norms for hydrogen training: Customer	1.83	1.73	2.00	3.13	6.985	<.001*
31_2	Negative subjective norms for hydrogen training: Regulator	1.66	1.57	1.83	2.00	2.381	.068*
32_1	Hydrogen training preferences: A course with TAFE or other training provider (less than 1 week)	4.33	4.64	4.27	4.57	3.809	.010*
32_2	Hydrogen training preferences: A course with TAFE or other training provider (more than 1 week)	3.61	3.82	3.77	4.63	2.851	.036*
32_3	Hydrogen training preferences: Onsite training (workplace training)	3.84	4.04	4.02	4.63	2.791	.039*
32_9	Hydrogen training preferences: Evening training	3.96	3.71	3.70	4.00	3.532	.014*
32_10	Hydrogen training preferences: Daytime training	3.75	4.02	4.15	4.43	8.017	<.001*

7.3.4 One-way ANOVA: Respondent work location

#	Question	Suburban/ Metropolitan	Regional	Metropolitan and Regional	F value	ρ
13	Intention to undertake training in the future	4.08	3.98	4.22	3.583	.028*
14	Actual training practices over the past three years	2.21	2.26	2.56	12.121	<.001*
15	Positive attitude towards additional training	4.37	4.29	4.52	4.214	.015*
17_1	Behavioural beliefs about additional training: The short to medium term competitiveness of the business I work in/own	4.07	3.93	4.20	4.593	.010*
18_7	People influential on trades practice: Insurers	3.62	3.77	3.79	3.021	.049*
19_6	Positive subjective norms: Employer (if not self-employed)	3.85	3.80	4.03	3.904	.021*
19_7	Positive subjective norms: Insurers	3.51	3.71	3.68	3.032	.049*
23_1	Negative behavioural controls: Availability of training opportunities provided by TAFEs or other training organisations	3.17	3.53	3.32	1.105	.014*
23_4	Negative behavioural controls: Availability of training opportunities provided by suppliers or manufacturers	3.04	3.41	3.17	5.080	.006*
23_6	Negative behavioural controls: time	3.40	3.76	3.49	5.060	.007*
23_7	Negative behavioural controls: distance	3.39	3.93	3.46	1.488	<.001*
24_6	Knowledge sources: employer	2.89	2.64	3.17	8.148	<.001*
24_7	Knowledge sources: Colleagues in my business	2.90	2.65	3.05	6.350	.002*
25	Confidence in describing the properties/characteristics of hydrogen gas to others	2.85	2.82	3.13	4.890	.008*
26	Ability to describe Australia's plans for a future hydrogen industry to others	2.62	2.47	2.85	5.480	.004*
29	Intention to undertake hydrogen training	4.58	4.55	4.70	3.845	.022*
30_3	Positive subjective norms for hydrogen training: Colleagues/Peers	3.85	3.82	4.03	4.221	.015*
30_6	Positive subjective norms for hydrogen training: Employer (if not self-employed)	3.97	3.89	4.16	4.068	.017*
32_2	Hydrogen training preferences: A course with TAFE or other training provider (more than 1 week)	3.72	3.46	3.75	3.152	.043*
32_3	Hydrogen training preferences: Onsite training (workplace training)	3.72	3.46	3.75	4.576	.011*
32_7	Hydrogen training preferences: Training sessions with an association	3.89	3.75	4.01	3.636	.027*
33	A transition to hydrogen will benefit the plumbing/gasfitting industry	4.18	4.22	4.35	3.175	.042*

7.3.5 One-way ANOVA: Respondent business size

#	Question	1 person	2 people	1-4 people	5-19 people	20-199 people	200+ people	F value	ρ
13	Intention to undertake training in the future	3.99	4.15	4.12	4.30	4.23	4.00	2.462	.032*
14	Actual training practices over the past three years	2.14	2.40	2.41	2.60	2.48	2.29	5.873	<.001*
17_1	Behavioural beliefs about additional training: The short to medium term competitiveness of the business I work in/own	4.01	4.10	4.00	4.25	4.28	4.02	2.427	.034*
17_2	Behavioural beliefs about additional training: The long-term viability of my plumbing/gasfitting trade	4.25	4.41	4.16	4.38	4.50	4.44	2.288	.044*

17_5	Behavioural beliefs about additional training: Providing assistance or advice to colleagues about products and practices	4.26	4.50	4.29	4.46	4.59	4.51	3.462	.004*
17_9	Behavioural beliefs about additional training: Increasing my career opportunities	3.98	4.17	3.93	4.31	4.30	4.12	4.061	.001*
18_6	People influential on trades practice: Employer (if not self-employed	3.64	3.72	3.97	4.10	4.21	4.22	9.943	<.001*
19_3	Positive subjective norms: Colleagues/Peers	3.72	3.89	3.76	4.04	4.15	3.63	5.740	<.001*
19_5	Positive subjective norms: Family	3.52	3.78	3.42	3.61	3.71	3.28	2.476	.031*
19_6	Positive subjective norms: Employer (if not self-employed)	3.63	3.80	3.94	4.15	4.28	4.05	10.445	<.001*
20_6	Negative subjective norms: Employer (if not self-employed)	2.02	1.94	1.78	1.78	1.73	2.13	2.555	.026*
20_9	Negative subjective norms: Associations for which I am a member of (e.g. Master Plumbers)	1.94	2.09	1.89	1.92	1.78	2.43	2.875	.014*
22_8	Positive behavioural controls: Distance	3.94	3.79	3.60	3.76	3.66	3.63	2.776	.017*
24_6	Knowledge sources: Employer	2.60	2.89	3.23	3.17	3.28	2.98	7.508	<.001*
24_7	Knowledge sources: Colleagues in my business	2.66	2.88	2.83	3.19	3.40	2.87	9.399	<.001*
24_9	Knowledge sources: YouTube	1.81	1.78	1.61	1.52	1.76	1.49	3.401	.005*
28_9	Behavioural beliefs about hydrogen training: Increasing my career opportunities	4.23	4.31	4.36	4.49	4.47	4.43	2.432	.033*
30_3	Positive subjective norms for hydrogen training: Colleagues/Peers	3.82	3.97	3.88	4.09	4.03	3.63	2.887	.014*
30_6	Positive subjective norms for hydrogen training: Employer (if not self employed)	3.74	3.96	4.09	4.27	4.34	4.15	8.251	<.001*
32_3	Hydrogen training preferences: Onsite training (workplace training)	3.74	3.97	3.88	4.11	4.14	3.93	3.513	.004*
32_9	Hydrogen training preferences: Evening training	3.94	3.98	3.87	3.68	3.95	3.41	2.610	.024*
32_13	Hydrogen training preferences: Staggered training (sessions spread out over time)	3.65	3.73	3.36	3.39	3.67	3.79	2.627	.023*

8. References

ABS. (2022). TableBuilder: Characteristics of Employment, 2014 to 2021. Retrieved from https://www.abs.gov.au/statistics/labour/earnings-and-working-conditions/characteristics-employment-australia/latest-release

AIS. (2019). *Skills Forecast 2019: Gas*. Retrieved from https://www.australianindustrystandards.org.au/wp-content/uploads/2020/08/UEG-SF-FULL-2019.pdf

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behaviour*. New York: Springer-Verlag.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. doi:https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2016, 9/11/2016). *The Theory of Planned Behavior: Focus on Persuasion.* Paper presented at the Dr. Melvin L. DeFleur Distinguished Lecture Series, Boston University, Massachusetts.

Arbuckle, J., & Wothke, W. (1999). *Amos 4.0 User's Guide*. Chicago, USA: Marketing Department SmallWaters Corporation.

Archer, R., Elder, W., Hustedde, C., Milam, A., & Joyce, J. (2008). The theory of planned behaviour in medical education: a model for integrating professionalism training. *Medical education, 42*(8), 771-777. doi:10.1111/j.1365-2923.2008.03130.x

Ates, H. (2019). Elementary school teachers' behavioral intentions for healthy nutrition: Extending theory of planned behavior. *Health education (Bradford, West Yorkshire, England), 119*(2), 133-149. doi:10.1108/HE-11-2018-0056

Blok, V., Wesselink, R., Studynka, O., & Kemp, R. (2015). Encouraging sustainability in the workplace: a survey on the pro-environmental behaviour of university employees. *Journal of Cleaner Production, 106*, 55-67. doi:10.1016/j.jclepro.2014.07.063

Cheung, S. O., Wong, P. S. P., & Lam, A. L. (2012). An investigation of the relationship between organizational culture and the performance of construction organizations. *Journal of business economics and management, 13*(4), 688-704. doi:10.3846/16111699.2011.620157

Gambhir, A., Green, F., & Pearson, P. (2018). *Towards a just and equitable low-carbon energy transition*. Retrieved from https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/26.-Towards-a-just-and-equitable-low-carbon-energy-transition.pdf

Gu, D., Guo, J., Liang, C., Lu, W., Zhao, S., Liu, B., & Long, T. (2019). Social Media-Based Health Management Systems and Sustained Health Engagement: TPB Perspective. *International journal of environmental research and public health, 16*(9), 1495. doi:10.3390/ijerph16091495

Hagger, M. S., & Chatzisarantis, N. L. D. (2009). Integrating the theory of planned behaviour and self-determination theory in health behaviour: A meta-analysis. *British journal of health psychology, 14*(2), 275-302. doi:10.1348/135910708X373959

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis 5th Ed*. Upper Saddle River, NJ: Prentice Hall.

Heery, E., & Noon, M. (2017). Upskilling. Retrieved from https://www.oxfordreference.com/view/10.1093/acref/9780191827822.001.0001/acref-9780191827822-e-1363

Jalilvand, M. R., & Samiei, N. (2012). The impact of electronic word of mouth on a tourism destination choice: Testing the theory of planned behavior (TPB). *Internet research, 22*(5), 591-612. doi:10.1108/10662241211271563

Jashapara, A. (2003). Cognition, Culture and Competition: An Empirical Test of the Learning Organization. *Learning Organization, 10*(1), 31-50.

Jöreskog, K., & Sörbom, D. (1996). *LISREL 8: Users reference guide*. Hillsdale, N.J: Lawrence Erlbaum Associates.

Judge, M., Warren-Myers, G., & Paladino, A. (2019). Using the theory of planned behaviour to predict intentions to purchase sustainable housing. *Journal of Cleaner Production, 215*, 259-267. doi:10.1016/j.jclepro.2019.01.029

Kelly, A. (2020). *Plumbing Services in Australia*. Retrieved from https://my-ibisworld-com.ezproxy.lib.rmit.edu.au/download/au/en/industry/324/1/0/pdf

Molenaar, K., Washington, S., & Diekmann, J. (2000). Structural equation model of construction contract dispute potential. *Journal of Construction Engineering and Management, 126*(4), 268–276.

Si, H., Shi, J.-g., Tang, D., Wu, G., & Lan, J. (2020). Understanding intention and behavior toward sustainable usage of bike sharing by extending the theory of planned behavior. *Resources, conservation and recycling, 152*, 104513. doi:10.1016/j.resconrec.2019.104513

Van der Merwe, M., & Kagee, A. (2006). Predicting treatment adherence among patients attending primary health care clinics : the utility of the Theory of Planned Behaviour : health psychology. *South African journal of psychology, 36*(4), 699-714.

Webster-Wright, A. (2009). Reframing Professional Development through Understanding Authentic Professional Learning. *Review of educational research, 79*(2), 702-739. doi:10.3102/0034654308330970

Wong, P., Cheung, S., & Fan, J. (2009). Examining the relationship between organizational learning styles and project performance: A structural equation modeling approach. *Journal of Construction Engineering and Management, 135*(6), 497-507.
Wong, P. S. P., Demertjis, M., Hardie, M., & Lo, C.-Y. (2014). The effect of unlearning on organisational learning behaviour and performance in construction contracting organisations. *International Journal of Project Organisation and Management, 6*(3), 197–214.

THIS PAGE SHOULD BE LEFT BLANK

Future Fuels CRC

Enabling the Decarbonisation of Australia's Energy Networks

www.futurefuelscrc.com

info@futurefuelscrc.com

Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program