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Skills and competencies for sustainable construction: Perspectives of construction trades

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Disclaimer

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Abstract

This report examines the skills and competencies that construction trades, especially builders, need to support sustainable construction. It is part of a broader research initiative aimed at accelerating workforce development for sustainable building practices in Aotearoa New Zealand. The study combines qualitative interviews with more than 60 industry professionals and a nationwide survey of 308 construction sector workers. Findings highlight that builders tend to learn on the job, with zero-carbon knowledge developing as demand arises rather than through proactive training. Industry professionals emphasise the role of client demand, design specifications and government regulation in driving sustainable practices. A trickle-down model of sustainable construction suggests that early adopters such as large firms can influence broader industry upskilling. Our research outlines that enhanced training programmes, stronger policy support and industry-wide collaboration, especially with technical and vocational education, are critical to embed sustainable construction into standard construction practices. By aligning education, regulation and market incentives, Aotearoa New Zealand's construction sector can better contribute to national climate goals and the transition to a zero-carbon built environment.

Keywords

Zero carbon, sustainability, skills, practices, training, technical education, vocational education.

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Key insights

- Knowledge and practice of sustainable construction, especially zero carbon, need to be improved across the workforce.
- Waste minimisation was an area of sustainable construction practice that could provide a way for greater sustainability to be undertaken on site.
- Regulation and client demand are needed to facilitate development of sustainability skills and competencies.
- Construction trades suggest that designers, manufacturers and suppliers have a pivotal role in helping to develop sustainability skills and competencies.
- A culture of learning is needed to support the development of sustainable construction so it becomes part of business as usual construction practice rather than an add-on or something different.
- Construction worksite culture is an important element in development of sustainable construction skills and competencies, especially for inexperienced workers. Creating a supportive environment where people can ask questions freely is highly valued among the trades.

Access the core competencies and learning outcomes and a climate action checklist for construction trades in *Skills and competencies for sustainable construction: The role of construction trades* at www.branz.co.nz/environment-zero-carbon-research.

1. Introduction

This report outlines research from *The Future of Work: Accelerating skills development for zero-carbon construction*, a project funded be Building Research Levy and ConCOVE Tūhura and led by BRANZ as part of the *Transition to a zero-carbon built environment* research programme. The aim of the project is to provide the construction sector with the necessary resources, knowledge, skills and competencies to make effective zero-carbon decisions for accelerating skills development for zero-carbon construction.

This report examines the skills and competencies that are required for sustainable construction from the perspective of construction trades – people who apply their skills and training to build or repair physical structures and systems such as builders, carpenters, plumbers, electricians, labourers and many more.

Throughout this report, the term 'sustainable construction' is used to encompass the process of designing and building zero-carbon and environmentally friendly buildings. While some in the construction sector interpret sustainability, especially 'zero carbon', as solely reducing carbon emissions, our focus is on the skills and competencies within the construction process.

This report outlines the challenges and opportunities for developing skills and competencies for sustainable construction, especially addressing the knowledge and practices to reduce greenhouse gas emissions from construction. We suggest there is an opportunity to leverage existing capabilities such as existing waste minimisation practices but also a need to design opportunities for developing skills and competencies that enable a supportive environment that can facilitate collaboration and communication as pivotal attributes. Furthermore, we highlight that greater leadership is needed from government and the sector for improved regulation and skills standards that promote sustainability and decarbonisation within construction in order to help drive change in the sector.

1.1 Research aims

The Future of Work research project focuses on three key questions:

- What expertise (knowledge, skills and competencies) is required to deliver zero-carbon buildings throughout their life cycle?
- Does the building and construction industry currently possess the necessary expertise to deliver zero-carbon buildings? If not, what are the barriers to developing and deploying this expertise across the industry?
- How should this expertise be provided to ensure effective implementation?

2. Methodology

2.1 Interviews

We conducted qualitative semi-structured interviews with more than 60 architects, designers, builders and representatives from professional organisations. Our participants represented a diverse range of construction trades and levels of experience – from apprentices to sector leaders in sustainability.

The key interview questions focused on:

- understanding each participant's skills, training and experience
- gathering views on who holds responsibility for sustainable construction projects
- assessing participants' knowledge of sustainability practices within the construction process
- exploring participants' experiences with projects aimed at reducing carbon emissions
- critically reviewing the draft skills and competencies for sustainable construction
- self-assessing how participants' skills, knowledge and experience align with the draft skills and competencies
- discussing experiences and challenges related to upskilling, particularly in skills and competencies for sustainable construction
- identifying sources of advice on sustainable construction
- highlighting barriers faced by construction trades in acquiring sustainable construction skills and competencies
- determining the most effective methods for upskilling in sustainable construction skills and competencies.

2.2 Data analysis

All data was de-identified, and participant codes were stored in separate electronic files. Thematic analysis was conducted using inductive reasoning, guided by Gibbs' (2007) framework:

- Transcription, familiarisation and immersion into the data.
- Code building.
- Dis/confirmatory theme development.
- Data consolidation and interpretation.

The researchers discussed and reviewed the emerging codes and organisation of themes. Based on Gibbs' framework, key themes emerged from the data, which have structured this report.

2.3 Ethics

A BRANZ human research ethics application (ER13203b) was submitted for this research project and received ethical approval on 11 December 2022, following a review in accordance with the BRANZ Ethics in Our Work Involving Human Participants Policy. Ethical conduct was maintained throughout the research process. All participants provided informed consent to take part in the study. Non-organisational participants were compensated with a $100 Prezzy card for their time and travel expenses.

3. Background

To meet the 2050 greenhouse gas emissions reduction targets outlined in the 2016 Paris Agreement on climate change, the construction sector must develop the skills and competencies necessary to design, build and recycle/reuse buildings to achieve net-zero greenhouse gas emissions. Our research indicates that, while technical skills remain crucial for the transition to sustainable construction, these emissions reduction targets will be unattainable unless current weaknesses in vocational education, training and qualification structures are addressed or reconfigured to include sustainability, especially zero-carbon knowledge.

Enhancing sustainable construction skills and competencies within the building and construction industry will improve collaboration among construction teams, helping Aotearoa New Zealand to meet its zero-carbon goals and ensuring that sustainable construction practices become standard within the sector.

3.1 Nationwide survey about sustainable construction

This research project aimed to understand the current knowledge and experience of sustainable construction within Aotearoa New Zealand's building and construction industry. The 2022 nationwide survey investigated:

- awareness of climate change among construction professionals
- knowledge and practical experience related to sustainable construction skills, and
- preparation for the transition to sustainable construction, including education and preferred learning methods.

Of the 308 individuals participating in the survey, representing a diverse range of occupations and experience levels, 41% had more than 20 years' industry experience, 31% had 10–20 years' experience and 28% had less than 10 years' experience. In terms of participants' main occupations, 45% were in construction trades, primarily working on residential stand-alone buildings; 28% were architects, designers or engineers; and 20% were educators, sustainability managers, government officials or involved in infrastructure-based trades (Lockyer & MacGregor, 2023).

3.2 Awareness of climate change

One aim of the survey was to assess the level of climate change literacy among construction professionals in Aotearoa New Zealand. Climate change literacy refers to the sector's understanding of how construction activities contribute to greenhouse gas emissions. International research and initiatives have highlighted the importance of climate change literacy in driving positive change within the building and construction industry.

Survey participants were asked to rank the emissions produced during different stages of a building's life cycle from highest impact (1) to lowest (6). These rankings are presented in Table 1, alongside BRANZ's rankings of life cycle stages based on carbon emissions from life cycle assessment reference buildings. The survey participants most commonly ranked embodied carbon – the carbon released during the life cycle of building materials, including extraction, manufacturing, transport, construction and materials – as having the highest impact. This was followed by carbon released during the construction process. Emissions related to building operation were generally ranked lower.

Table 1. Ranking impact of emissions during the life cycle of a building

	Ranking by BRANZ's life cycle assessment	Ranking by survey participants
1 (highest emissions)	Operational carbon	Embodied carbon
2	Embodied carbon	Construction
3	Maintenance	Waste
4	Operational water use	Operational carbon
5	Waste	Maintenance
6 (lowest emissions)	Construction	Operational water use

These rankings indicate a gap in understanding of building-related emissions. BRANZ research undertaken Dowdell and others (2021) has shown that operational carbon typically has the highest impact, while construction carbon has the lowest.

When participants were asked about their awareness of policy changes proposed by MBIE's Building for Climate Change programme, most were unaware of some or all of the proposed changes. Those working in construction trades were twice as likely as other occupational groups to be unaware of these policies. Despite this lack of awareness, 86% of participants supported MBIE making changes to address climate change.

3.3 Skills and experience of sustainable construction

The survey also aimed to assess the sector's current skills and experience as well as future needs regarding sustainable construction. Most participants acknowledged the importance of developing new skills and knowledge to address climate change such as:

- understanding how their work connects with other trades (96%)
- knowledge of general building, architectural and engineering principles (93%)
- awareness of the environmental impact of greenhouse gas emissions and climate change (83%).

When evaluating the sector's current skills, participants considered the building and construction industry to be either very competent or competent in the installation (58%) and maintenance (41%) of the building envelope. However, 41% of the sample rated the building and construction industry as not at all competent in understanding embodied carbon.

Overall, survey participants did not view themselves as experts in any area. Notably, there were significant experience gaps, with over half of the participants having no experience in calculating greenhouse gas emissions (75%), developing transition plans (60%) or carbon footprinting of design (58%).

3.4 Training for sustainable construction

The nationwide survey also assessed participants' satisfaction with current building and construction industry education and training on zero-carbon and sustainable construction. Most participants were either neutral (40%), somewhat dissatisfied (34%) or extremely dissatisfied (15%) with the available options. They expressed a desire for more information and training through professional development workshops, seminars and trade talks to support their zero-carbon journey.

Findings from our survey indicate that the construction sector is ready for change, with practitioners largely supportive of actions to address climate change. Participants also showed a keen interest in and eagerness to acquire the skills and knowledge needed for the transition to zero-carbon construction.

While there is a clear desire for change, survey responses revealed a significant lack of knowledge and experience across the building and construction industry regarding sustainable construction skills and competencies. The current education and training programmes and opportunities available to the building and construction industry in this area are limited. To meet our zero-carbon targets, a substantial effort from the education sector will be required to provide resources through channels that suit the various professions within the sector.

3.5 Competency profile for construction trades

To ensure global warming does not exceed 1.5°C, we need to reduce carbon emissions from new residential buildings by 72% (McLaren et al., 2020). The construction sector faces significant challenges due to limited experience with sustainable design and construction. Upskilling the workforce is essential, requiring a substantial effort from the education and training sector to provide guidance and resources across all parts of the building and construction industry.

To better understand the challenges in implementing sustainable construction, we conducted interviews with practitioners from various construction trades, as well as designers and architects, focusing on the skills and competencies needed for sustainable construction. This report outlines the main findings and a competency profile for sustainable construction skills for construction trades. A separate report outlines the perspectives of architects and designers.

The key focus areas for construction trades are:

- zero-carbon knowledge
- zero-carbon practice
- zero-carbon building
- sustainable products
- waste minimisation, reuse and recycling
- water
- legal requirements
- whole build process
- personal capability.

4. Results: What construction trades told us

The qualitative semi-structured interviews built on the findings of the nationwide survey (Lockyer & McGregor, 2023), including the draft sustainable construction skills and competencies profile developed from that survey (see *Skills and competencies for sustainable construction: The role of construction trades* at www.branz.co.nz/environment-zero-carbon-research).

4.1 Skills and competencies profile for sustainable construction

The main finding from this research was not what builders[1] were able to tell us but rather what was not discussed regarding sustainable construction skills and competencies.

Most builders interviewed were unable to discuss the zero-carbon or sustainability competencies in a meaningful way. While there were aspects of the competencies that many builders were knowledgeable about, particularly waste minimisation, overall, the conversations focused heavily on barriers to delivery of sustainable buildings.

What follows is a summary of the themes that emerged from these interviews. Rather than focusing on the skills and competencies required to deliver sustainable buildings, it highlights the issues described by builders that appear to be impeding upskilling. This section also describes the pathway to sustainable construction skills uptake according to builders – a trickle-down model of sustainable construction delivery where upskilling is the byproduct.

4.2 Waste minimisation – a competency well understood but not enacted

Waste minimisation was by far the most discussed competency. While there were some examples of attempts at sustainable approaches, most commentary was around the challenges of waste minimisation. Examples were given about recycling of some materials, but typically only where there is an incentive to do so. Builders observed that there wasn't the infrastructure in place to sort materials for recycling and that the additional time to sort waste materials would cost them financially. Builders frequently reported that "you just get the skip in and just chuck everything in it", including large off-cuts and sometimes brand-new materials that remain unused at the end of a job.

Many builders spoke about the excessive use of plastic and other packaging that materials come in and expressed dismay at this unnecessary waste.

> "In a job, I'd go through outrageous amounts of plastic. I don't know why it's wrapped in so much plastic."
> (Builder)

There were examples of clients demanding that the waste on their build be managed sustainably, and builders were able to do so. Client demand as a driver for sustainable construction upskilling was a theme throughout these interviews.

[1] The term 'builder' is used to describe both builders and building apprentices in our study sample unless describing the experiences of apprentices specifically.

Builders were very aware of the need to reduce their waste and improve access to recycling and reusing of materials. They demonstrated that builders are competent in waste minimisation and were able to identify barriers that are preventing them from exercising this competency:

- The perception that sustainable waste minimisation is expensive and only big companies can afford to establish the systems to do it.
- Lack of (financial) incentive to sustainably manage waste.
- Lack of space on smaller sites for sorting bins.
- Challenges in communicating waste-minimisation protocols across diverse teams on site.
- The financial and time costs of sorting waste.
- A lack of recycling/reusing infrastructure to receive the waste.
- Perceived client preferences for brand-new materials rather than reused.

4.3 Who is responsible for driving sustainable construction skill development?

Builders identified several groups within the industry who they thought should be responsible for driving increased sustainable construction delivery. Builders tended to conflate delivery and competency, perhaps because delivery is a more familiar concept to builders than competencies and possibly due to their learning-on-the-job approach to upskilling. Some builders explained that they tend to upskill only when the need for that new skill and competencies is imminent. This means that skills and competencies will likely increase as the demand for sustainable construction delivery increases. The finding also indicates that increasing the demand for sustainable construction is likely to be an effective lever in encouraging sustainable construction processes, especially development of zero-carbon construction skills and competencies.

Client demand, or being contracted to deliver a sustainable construction, was frequently reported by builders as the driver for learning about sustainable materials and building practices. Many described examples of self-driven learning, demonstrating the personal competencies of curiosity and independence. There was a perception that sustainable construction was more expensive, and demand relies heavily on "wealthy clients" where budget is not an issue.

> "But the key defining factor of it is wealthy clients. If we didn't have wealthy clients, none of this would be happening."
> (Builder)

Designers were also identified by builders as being responsible for driving sustainable construction delivery, often in partnership with the client. This theme was essentially that clients demand, designers specify, then builders build.

> "In my experience, it's a hand-in-glove relationship between the designers in New Zealand and the clients. There has to be a desire from the clients, but they don't know what they're asking for, and so the designers have to be there with the knowledge and the opportunity and the products. So they need to either be aware or educated or interested, or they have to have this stuff available to them. And they have to have knowledge on it to be able to recommend it to clients who are interested and motivated."
> (Builder)

A few builders noted that, once the plans have been consented, they have very little input into how sustainable (or not) a building is going to be. This indicates that builders will need to be included in the design process if they are going to influence sustainable construction decisions. This, in turn, requires builders to be competent in the building sciences and sustainability skills required to design such buildings.

Builders often mentioned that manufacturers and suppliers have a pivotal role in development of sustainable construction skills and competencies. As they design and promote more sustainable materials options, builders will need to learn how to install them, including why they are a better option than the status quo.

Builders themselves were also identified as a group with responsibility for increasing sustainable construction. However, upskilling for sustainable construction was seen as an investment in time and money for builders, some of whom described themselves as "time poor" and sustainability as a "low priority" in the current economic environment.

> "I think there are bigger issues, much bigger issues within the industry, but we're talking about zero carbon and the warm fuzzies. So I think it's difficult for most of us to live that."
> (Builder)

In the absence of a financial incentive (demand), some builders said sustainable construction will have to be forced on the industry. Several said that central government will need to legislate sustainable construction into our building standards and regulations. Some went as far as to say that, without government intervention, sustainable construction won't happen.

4.4 Competency development and upskilling – culture of learning

Builders, particularly apprentices, described how they like to learn as well as some of the challenges of learning on site. Many explained that sustainable construction was not taught during their apprenticeship, and the few who had learned about it had sought out that knowledge independently.

When seeking information about a skill or unfamiliar product, builders mentioned several resources they rely on. Sustainable construction resources should utilise these established information channels. The most frequently mentioned resources were:

- Google – typically accessed by the builder on their smartphone while on site to help solve a problem right in front of them
- YouTube – also accessed directly from their smartphone while on site
- BRANZ resources – particularly bulletins and the helpline
- apprenticeship learning resources – bookwork or online
- manufacturers' guidelines – for information specific to the installation of a product or material
- suppliers – product information or resources and personal interactions with their local sales representative
- asking an experienced builder on site – the preferred option for many apprentices.

While apprentices and less-experienced builders reported that they preferred to ask other more experienced builders on site if they are unsure about something, this approach comes with challenges. Many builders reported having experienced working on building sites where questions were perceived as "annoying". Apprentices had to

"choose their moment" to ask questions, and many described actively employing diplomatic tactics to avoid angering more senior builders on site by asking too many questions. Some described holding on to their questions and saving them up to ask in the classroom rather than on site. One builder said that they would not ask about sustainability on site because there is a perception that sustainable or zero-carbon building is "woke" and they feared they would be ridiculed by their bosses.

Overall, there was a strong theme that building sites are not always supportive learning environments.

> "I've had to leave two roles. Because, yeah, I've had one … where I got an overwhelming response of: 'You ask too many questions.' And I was like, 'Oh, this is not the place for me. No way. I need to be able to ask questions.' And then another one. Yeah. So that the emotional intelligence of being able to understand when and how to ask questions and when to get your head down and just get on a spade is a really, really important skill for an apprentice. Also, the ability to pick your team, based on your learning style, I think is a very important one as well. But you, you just have to read the room of when it's appropriate to ask more in-depth questions. And just be aware of vibe, man, just be aware of the vibe."
> (Apprentice)

Some apprentices reported finding supportive on-site learning environments. They described builders who made time to demonstrate and explain things to them. Apprentices said they learned best when they were allowed to give things a go and to make mistakes, under supervision, and could learn from their mistakes in a supportive environment.

Many apprentices and qualified builders explained that they learned new skills best when they were taught why things were built and installed in particular ways. Some described not mastering how to do a particular task until they'd had the why explained to them.

> "You know, I guess it's just explaining to them, you know, I want this done here. But this is why you need to do it this way. Because of this, and then you explain and a few more processes down, they wouldn't know the whole job, but you could just give them a little bit more understanding. Because if you muck up this here, this is the complications."
> (Builder)

When training builders on sustainable construction approaches, it will be important to include information about why they should be building in a particular way. Understanding the why of sustainable construction will be critical to builder upskilling.

4.5 The path to sustainable construction according to builders – deliver it and the competencies will come

It is clear from the interviews with construction trades, especially with builders in this study, that Aotearoa New Zealand's construction sector has a long way to go in becoming competent in sustainable construction. Many builders acknowledged that sustainable construction, especially zero-carbon construction, simply isn't happening at scale yet and that there are pockets of resistance to a change in the direction of more

sustainable construction. This was not explained as being due to a lack of competency but rather that the barriers were typically financial or due to lack of demand or incentive. Builders said that, when asked to build a home sustainably, they would upskill themselves and deliver a sustainable building. Sustainable construction was seen as something that happened project to project, or even product to product, rather than being an overhaul of the entire building system or industry. The competencies identified as being crucial to that delivery were all but ignored.

Builders did have ideas about how sustainable construction could be rolled out across construction, again focused on delivery rather than competency development. Competency is seen as a byproduct of delivery. Builders frequently pointed to others within the industry to take responsibility for adopting sustainable processes and practices first. They posited the idea that the rest of the industry will follow once large companies, as early adopters, have proven the viability of sustainable approaches and invested in the infrastructure required to build sustainably. Across the interviews, a trickle-down model of increasing zero-carbon construction skills and competencies emerged.

Builders said several things were required to drive sustainable construction:

- Demand for sustainable buildings from clients.
- Competent designers advising clients and specifying sustainable materials.
- Manufacturers and suppliers making and promoting sustainable materials and products, generating demand and informing designers.
- Large companies that can afford to innovate and invest in upskilling and the infrastructure required to build sustainably (e.g. waste management infrastructure) operate as early adopters to test the pathways to sustainable construction.

Builders said that, once early adopters and fast followers begin delivering sustainable buildings, small and medium enterprises (SMEs) will follow suit (Figure 1).

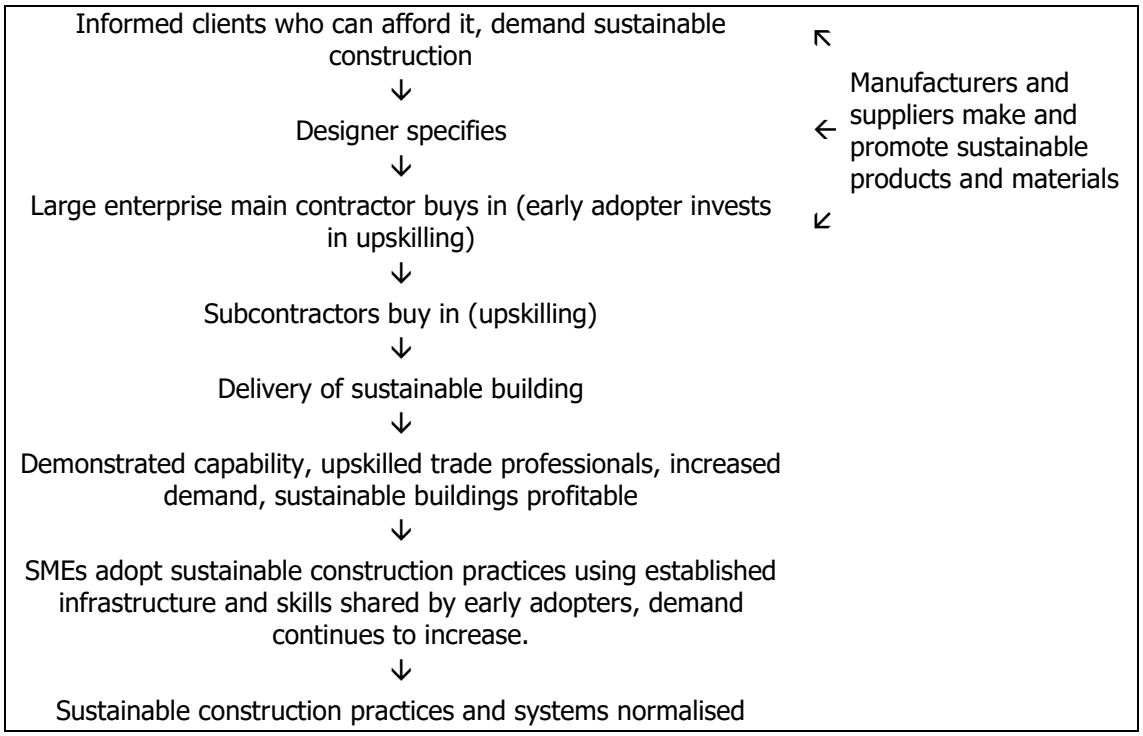

Figure 1. The trickle-down sustainability model according to construction trades.

Early adopters will facilitate the upskilling of subcontractors whose expertise can then be leveraged by SMEs as they venture into sustainable construction delivery.

> "I think [the] whole thing was like spill down … in the contract of the style like what the requirements were for the Green Star … and the actual owners of the building as well, which I think was [name redacted] at the time. They were pushing, they wanted the Green Star. And then [name redacted] wanted the Green Stars so then all the contractors underneath were going for the Green Star as well." (Builder)

Notably absent from the conversations about increasing delivery was consideration of what skills and competencies builders would need to enable this trickle-down model to work. Many builders do not appear to know what they do not know and only identify skills gaps when confronted with a new challenge in the plans of their current project. This approach to learning will need to be accommodated in any sustainable construction training or skills and competencies development programmes.

5. Conclusion

The transition to sustainable construction in Aotearoa New Zealand requires a unified effort from all the stakeholders within the construction sector. This report has highlighted the critical need for enhanced skills and competencies for construction trades.

Sustainable construction, especially zero-carbon, is in its infancy in Aotearoa New Zealand. Builders are aware of the need for better waste management and minimisation processes on site but perceive these to be costly, and the infrastructure to sort and recycle waste is lacking. Beyond waste minimisation, builders' understanding of sustainable construction, especially the required sustainable construction skills and competencies, was low. Builders gravitate towards discussions of delivery rather than skills and competencies, and upskilling is seen as a byproduct of delivery. Builders will seek out information and new skills when confronted with the need to do so in the plans of their current project.

Builders said that, in the absence of government regulations enforcing sustainable construction methods, the pathway to change is through increasing client demand, designers specifying sustainable materials, manufacturers and suppliers making and marketing sustainable materials and products and large construction companies taking on innovative projects as early adopters of sustainable construction. Builders said this would pave the way for SMEs to deliver more sustainable buildings, increasing competency through on-the-job learning and upskilling.

These findings demonstrate the importance of comprehensive education and training programmes, robust regulatory frameworks and strong leadership to drive sustainable practices. By fostering collaboration and integrating sustainability and zero-carbon principles across all disciplines, the building and construction industry can effectively contribute to the nation's climate goals and ensure a sustainable future.

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