



CONSTRUCTION EXPERT WORKING GROUP

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Australian Broadband
Advisory Council

Construction Expert Working Group Members

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Executive Summary

The Australian Broadband Advisory Council (the Council) advises the Australian Government on maximising the social and economic benefits of high speed broadband connectivity and digital technologies in key sectors of the Australian economy. The Council has established the Construction Expert Working Group (CEWG) to investigate the construction sector. The CEWG has a diverse membership from across the sector, including representatives from industry, government and peak bodies such as Bunnings Group, the Australian Constructors Association, the Victorian Department of Treasury and Finance and Infrastructure Australia.

Working closely with EY, the CEWG has undertaken a scoping study to better understand the current state of play on Construction Tech, including identifying barriers to its use, and opportunities to drive take up further. Along with the results of a survey of the construction sector already underway, this scoping study will inform the next phase of the CEWG's work, culminating in formal recommendations for consideration by the Council in 2022.

The key finding of the scoping study is that digital maturity is fragmented and that take up of digital technologies is significantly affected by the adversarial and competitive nature of the sector. In approaching the scoping study, the CEWG has considered digital maturity (as well as barriers and opportunities to greater take up of Construction Tech) across the different tiers/segments of the sector.

It has found that while many tier one and two companies are adopting Construction Tech (i.e. take up and use of digital connectivity and technology), more needs to be done to encourage smaller firms to digitise their workflows and processes, including lifting their awareness of the potential benefits. Given this, the CEWG will focus on SMEs who sit below Tier 1 and Tier 2 companies and provide the bulk of the labour in the sector.

While the potential economic benefits of increased take up of Construction Tech is significant, further modelling is required to be undertaken to ascertain the potential value of an aggressive uptake of Construction Tech.

The study identifies a number of challenges to the uptake of Construction Tech, predominantly around culture, skills and knowledge. Despite the challenges identified in the scoping study, the CEWG has observed some progress. At the operational level, integration of Construction Tech like Xero into the supply chain has the potential to deliver significant benefits to smaller operators, while more strategically, the establishment of bodies like the Australian BIM Advisory Board is providing leadership on the adoption of BIM and connecting key stakeholders from across government and industry.

The economic imperative to drive further take up of Construction Tech is clear. To achieve this, the CEWG has identified the importance of supporting effective change management across the sector, including identifying how current and emerging tech can help support productivity and leverage adoption where it has been most successful.

The need for a more highly digital skilled workforce is also critical, and needs to be considered in the context of both initial training (i.e. through universities and the VET sector) and professional development for the existing workforce

Following this scoping study, the CEWG is progressing the areas identified for further investigation for each of the core challenges identified, including engaging across government and industry to identify and leverage existing efforts. Fundamentally, the CEWG is interested in exploring how to recalibrate existing investment and operational decisions to support greater take up of Construction Tech, and to realise the considerable productivity benefits this would create. The CEWG is seeking to complete this work by June 2022.

Scope of Construction Sector

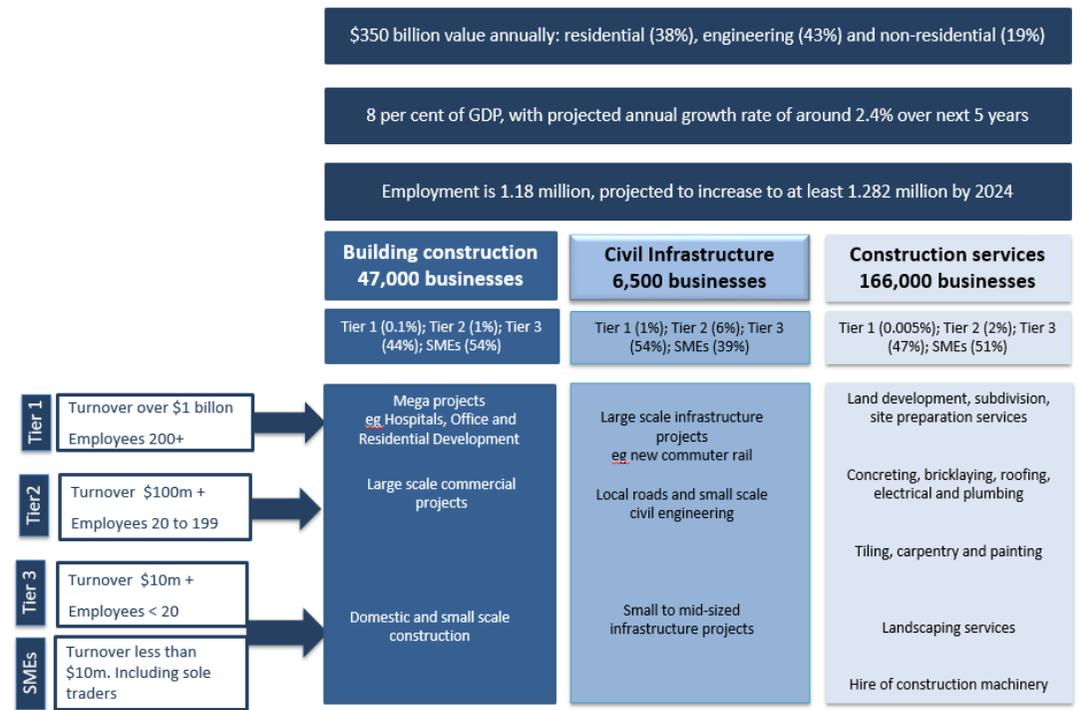
To bridge the gaps in introducing technology in training and development and the value chain, the CEWG has identified the need to better understand current workflow processes across each segment of the construction sector and how these could be improved through the take up of digital technologies. As a first step, the CEWG will undertake a workflow mapping process to identify supply chain processes, with a focus on the residential segment of the sector, to identify areas where digital tech adoption could have the most impact.

The CEWG will also explore ways to support improved engagement between government, industry and the peak bodies across the sector in key areas such as digital skills. States, territories, and the Australian Government can play a key role in leading the digital transformation of the construction industry. The CEWG’s scoping study indicates significant benefits could be delivered if learning outcomes and curriculum were better aligned with industry needs, including if and how micro-credentialing and flexible learning can be integrated into more traditional training approaches.

The CEWG is also keen to develop a deeper understanding of how funding and investment accelerators could help position Australia to deliver globally leading technology to address gaps and encourage the next generation of graduates and business builders to create innovative solutions to practical problems.

As shown in the *Snapshot of Industry Structure*, the sector covers a wide spectrum of work, split across tiers (size of organisation) and segments (type of work done). Across all segments, sole trader entities comprise a significant proportion of the total number of registered organisations, and as such, this cohort of small and medium enterprises (SMEs) is a key focus of the CEWG’s work.

Snapshot of Industry Structure



Spectrum of Work

Workflow and Value Chain

- Undertake a workflow mapping process for the construction industry, which identifies manual processes and potential areas of digitisation.
- Consider best mechanisms to communicate and engage with industry through peak bodies and other stakeholders to standardise data requirements for Construction Tech.
- Examine the benefits of an increase in change management capability and understanding on the people-impact of new technologies to see if this will achieve more successful investment.
- Examine governments' procurement arrangements and how they can provide investment security by specifying consistent technology demands across their large investment portfolio.

Skills and Training

- Explore how micro-credentialing and flexible learning opportunities can be integrated with traditional multi-year qualifications.
- Consider mechanisms for enabling regular engagement between the industry and education providers to align learning outcomes with industry needs, including a common framework and taxonomy.
- Examine ways to communicate with those entering education on the careers and opportunities open to them in the industry if they pursue training in digital technology.
- Examine incentives for those willing to train in the use of these technologies and increase appetite for risk in contemplating the adoption of new technologies.

Technology Adoption and Gaps

- Examine the benefits of a gradual increase in technology uptake by organisations and how this may yield more frequent successful outcomes than large drastic investments.
- Examine how industry can share the lessons learnt in investment for the sector's mutual benefit, rather than adopting a market protection position.
- The full economic value of the adoption of Construction Tech should be considered in future research as part of a tech audit, including identification of currently available technologies, their role, the barriers and benefits, broken down by subsectors.

Investment and Collaboration

- Further work to fully understand the business case for adoption is required
- Explore need for government funding in the forms of grants and seed investment to enable teams to generate new businesses targeting the industry.
- Consider creation of a hub and spoke innovation centre model for the construction industry with city centre spaces and regional roadshows.
- Examine options for Construction Tech accelerator program in partnership with industry with agreement to pilot/purchase/invest

Desktop Analysis – Industry Consultation – Workshops – Economic Modelling – Case Studies

Scope of Construction Sector

During the course of this scoping study, it is clear that while there is scope for improvement in take up of Construction Tech across all tiers, SMEs are the cohort for whom take up is lagging the most, and for whom the potential benefits of Construction Tech may be less clear.

In terms of the different segments, the scoping study has focused on building construction and civil/infrastructure. The third segment identified in the diagram below, construction services, has been considered in the context of an enabler to the construction sector and the segment that can deliver many of the Construction Tech solutions.

Tier one and two firms have the highest representation in the civil infrastructure segment, comprising 7 per cent combined, compared to 1.1 per cent in the building construction segment. These figures disguise, to some extent, the dominance of these tier 1 firms, however, with the top 20 firms accounting for 68 per cent of contracts won.

Approximately 80 per cent of construction work takes place in residential building and infrastructure development, with the remaining 19 per cent being non-residential. Among the non-residential building construction sector, approximately 30 per cent is by the public sector and over half of that expenditure is on educational and health care facilities.

In the residential building subsector, the private sector has almost absolute dominance, delivering 99 per cent of all projects. The segment in which the public sector has the highest share of projects delivered is the non-residential sector, making up 30 per cent of the value of work. Of this 30 per cent, there is a heavy focus on health and educational buildings, where the public sector

outweighs the private sector by a ratio of two to one.

Outside these two subcategories, the remainder of public expenditure occurs in entertainment venues and non-residential buildings not elsewhere classified (a further 32 per cent between the categories), with smaller levels in office space and transport buildings.

The engineering category, encompassing infrastructure development including roads and bridges, harbours and port infrastructure, water and electricity infrastructure, and heavy industry – is again dominated by the private sector, however a large amount of that private sector activity is in the delivery of public infrastructure.

On average, approximately 71 per cent of the value of building work done is undertaken in the capital cities of Australia. However, the Regional Movers Index (RMI) shows a seven per cent rise in people moving from metropolitan to regional areas since 2018 (Regional Australia Institute 2021).

Regional employment opportunities are on the rise. Regional jobs are making up almost one third of job vacancies across the country with trade workers, together with care and clerical workers, making up the largest growth in regional job vacancies (Houghton 2021; Regional Australia Institute 2021).

This trend towards regional translates into construction. Availability of land and lower costs has driven the build-to-rent construction market regionally though this demands more capital than build-to-live which tends to be more common regionally.

Progress Since 2017

This scoping study is designed to provide an update on the progress of Construction Tech adoption since 2017 and the publication of StartUp Australia's Digital Foundations: How Technology is Transforming Australia's Construction Sector report. While the 2017 report noted that there has been considerable progress in the take up of Construction Tech, it found that there was still much more to achieve. It made a number of recommendations, including:

- developing a set of standards across technology adoption
- conducting a review into universal adoption of BIM to consider need for mandatory adoption
- providing additional support for collaborative research initiatives focused on Construction Tech
- supporting events to connect emerging companies with customers and investors.

In our analysis of the recommendations as part of this scoping study, the CEWG notes that progress of Construction Tech since the 2017 report has been patchy and a more concerted, proactive approach, based on collaboration between government and industry, is required to really build momentum. Further information on the recommendations of the 2017 report and progress against each to date is at [Appendix A](#).

At the Tier 1 level, there is evidence of investment in teams with digital construction expertise, lateral hires of technology experts, a move to paperless or near paperless projects, as well as piloting and uptake of digital construction solutions. However, there is the perception that digital adoption in the construction sector is still lagging, with the industry yet to experience its 'Uber moment'.

It is the CEWG's view that the patchy response to the 2017 recommendations reflects the fact that significant barriers to digital take up have not been addressed – it is partly due to a lack of will (on both the part of industry and governments) but also due to the fundamental nature of the sector, the diversity within it, harsh conditions of construction, the tight margins companies are operating in and the complexity of contractual arrangements. Integrating technology can also take a back seat to the more tangible and immediate demands 'out on site'.

The impact of COVID-19 on the uptake of technology

COVID-19 has accelerated greater acceptance of digital ways of working. Construction Tech is expected to benefit from this shift, resulting in growth at a faster pace than may have been possible had the pandemic not have occurred (D'Esposito 2021; McKinsey 2020; Snyder 2020).

Due to COVID-19, three years of construction tech growth and adoption has been compressed into a much shorter period (D'Esposito 2021). Restrictions related to physical distancing have forced industry to actively think digitally. For example, collaboration that would have previously happened in-person has been shifted to the virtual environment.

To keep construction projects running during COVID-19, inspections and collaboration were managed virtually which led to a rise in uptake of technology such as digital collaboration software platforms, scanning tools, safety/wearables, BIM or drones (Construction Executive 2021; D'Esposito 2021). COVID-19 is also linked to advances in the use of prefabrication as the decentralisation of the building process allowed for COVID-19-safe practices, better quality and time management and fewer labourers on site.

Progress Since 2017

The impact that COVID-19 has had on the global economy has established fears of economic downturn. Disruptions in the supply chain has caused delays in progress and investment (IBIS World 2021; Kelly 2021). Therefore, the construction sector had to look at how to stay competitive, which includes leveraging technology (McKinsey 2020; Kelly 2021). While the sector is in high demand, there is a high level of employee churn, and a lack of available labour can mean that companies have to turn down projects as they simply don't have the resources to take on additional work (McKinsey 2020).

Benefits of Construction Tech

The adoption of Construction Tech could deliver significant benefits across the sector, including supporting improved productivity and efficiency, reducing or eliminating errors, and freeing up resources to take on more projects.

Greater take up of Construction Tech could deliver significant economic dividends. The size of the dividend will of course depend on level at which Construction Tech uptake improves, and the speed at which firms at the lower end of the digital maturity curve (often small to medium enterprises) increase their use/investment in digital technologies.

While the economic potential is enormous, further work needs to be undertaken to quantify the size of the productivity gain that could be realised. Construction Tech has the potential to drive productivity gains in labour efficiency, however there is also potential to save costs by standardisation of processes and material saving in the management of inventory. Further, Construction Tech is a means of achieving higher environmental outcomes in the construction sector.

The adoption of digital tech could also play an important role in addressing the estimated 105,000 shortage of construction roles in Australia by 2023, according to the Infra Australia report. There is an urgent need to find ways to do more with less if the sector is to deliver the planned pipeline of works and ensure the associated economic stimulus is realised.

Aside from the potential uplift in GDP, the strengthened and more efficient domestic economy strengthens a range of other key economic measures,

resulting in greater competitiveness in international market and a growth in export.

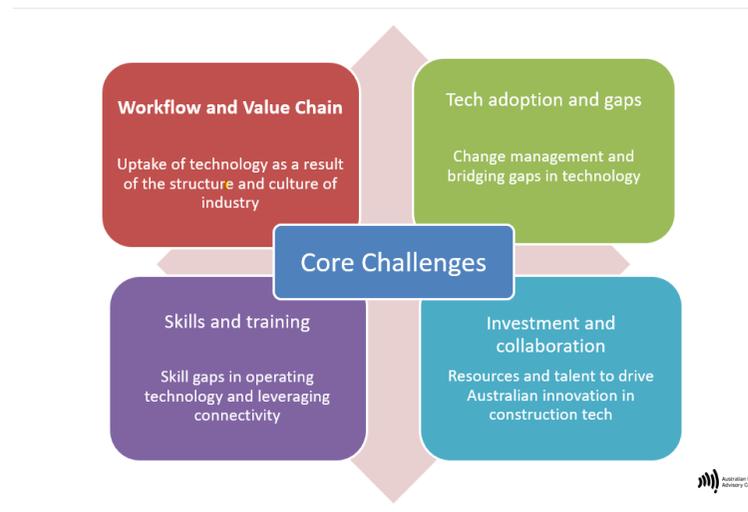
The increased efficiency of the construction sector also has spill over effects across the broader economy. For example, the manufacturing sector is a major input into capital formation, providing many of the domestic material inputs into construction. This supply chain linkage (in particular) helps to increase output in manufacturing by \$0.7 billion in 2030-31.

The opportunity for significant cost savings will spur growth in the construction sector, particularly through the enhanced capital formation program previously described.

Although there is clearly change happening in regional areas, a great deal of the construction sector that is anticipated to benefit from Construction Tech (specifically, large scale infrastructure and building construction excluding detached housing) is located in the major cities of Australia, both in an absolute and a relative sense. Further, due to the nature of the firms that undertake the work we anticipate location to be an insignificant barrier to Construction Tech adoption in the regions.

Sector Challenges

The core challenges identified by the CEWG to date are interconnected and have differing impacts depending on which segment of the sector is being considered. As such, while the CEWG notes that an integrated and sectoral-wide response is required, specific actions might need to be calibrated to the differing needs of some cohorts, such as SMEs or operators in regional areas.



While connectivity has not been identified by the CEWG as a core challenge, the CEWG notes that it is a critical enabler in supporting further take up of Construction Tech. This is particularly the case in regional and peri-urban areas, where connectivity may be relatively poor compared to metro areas. It is also important to note that as the volume and profile of Construction Tech increases, connectivity will become increasingly essential.

In approaching the four challenges (and identifying areas for further investigation), the CEWG will underpin its analysis with a particular focus on SMEs as a sub-sector, along with regional/peri-urban areas. The Office for Projects Victoria (OPV) is currently undertaking a workflow analysis for tier ones, and it is the CEWG's view that a similar analysis targeted at SMEs could be useful in better identifying barriers and opportunities for that segment.

Workflow and Value Chain

Technology solutions for SMEs have been at best piecemeal and tended to seek to resolve specific industry issues rather than create integrated technology stacks or platforms. Recently there has been some progress in addressing this issue, however, this scoping study has found that many firms across the sector, particularly SMEs, still may not see the value in investing in digital technologies. As a result, they have stuck with traditional business processes (eg paper-based plans and invoices).

Part of the issue when it comes to workflow issues and the use of technologies in place of traditional business processes is the lack of guidance on the uptake of technology, and awareness of the benefits it can deliver. Without clear guidance on the benefits and challenges, many businesses do not feel confident in investing in technology that they have little knowledge of, and unsure they have the skills to utilise.

There is also a cultural barrier where 'business as usual' is seen as good enough (which can undermine any momentum towards take up of Construction Tech, particularly for SMEs). This may be exacerbated by the lack of diversity across the workforce and by competing priorities (eg compliance with evolving regulatory frameworks).

Another cultural barrier is created by the adversarial nature of the sector, which can create conditions in which collaboration (and the development of collaborative and interoperable platforms and technologies), isn't considered a priority by industry participants.

Where digital solutions are used, they tend to be issue-specific fixes (eg accounting software for SMEs) rather than system-level solutions or leveraging data across the supply chain. Current contracting arrangements also hinder collaboration and universal adoption of Construction Tech as organisations seek to protect IP and streamline costs in order to maintain a competitive edge.

CASE STUDY: a small Victorian-based builder

Typically John produces 5-6 homes a year. He has used the same process and suppliers for the last twenty years. His wife helps in the business and they have three trades on the tools and use a range of sub-contractors for the specialist tasks. He has a mobile phone as his technology. His wife uses MYOB to run the business and pay the accounts.

John can't (or won't) use the computer. He spends 50 per cent of his day on the phone managing the logistics – from order to sub-trades to liaising with his clients. His marketing is purely word of mouth. He doesn't really understand technology and believes MYOB is his management system. He can't imagine changing how he operates. Beside he is 55 and why change when it has worked so well and he makes a good living?

The high prevalence of disputes can also negatively impact on the willingness of project participants to openly share information beyond that which they are contractually obliged to provide. As information can be used to prepare or defend against contractual claims. This information hoarding is a major impediment to the adoption of many digital technologies as they are based on platforms that require open and transparent sharing of project information.

Although an improving trend is emerging, Australia is lacking specific integrated project delivery contracts (e.g. USA) or collaborative contracts (i.e. UK) that align the interests of stakeholders and team members using a collaborative, value-based process that spreads responsibilities and incentives between project owners and those involved in the delivery of construction projects.

With greater control and ability to lead the way, the value of Construction Tech is considered to be greater for organisations that offer end-to-end solutions. However, the sector at large does not operate end to end, making streamlined adoption of digital difficult in the absence of standardised solutions.

Technology Adoption and Gaps

Construction Tech is generally understood to include smart technologies that leverage the internet of things (IoT) and data to improve productivity, sustainability, quality and safety. Examples include robotics and artificial intelligence, prefabrication and 3D printing, drones, BIM and digital twins.

Alongside these technologies sit project management and estimation software, focused on helping the time poor builder increase productivity and customer satisfaction through advances in accounting, planning, and asset management. While project management and estimation tools might not be the first to come to mind when thinking about Construction Tech more broadly, they are core to the process and intrinsically linked to connectivity by the sector, especially by smaller players in the sector.

While there may be general visibility of the types of Construction Tech available, this scoping study indicates that there isn't a corresponding awareness of how that Construction Tech can be applied to deliver efficiencies both within a firm and across the supply chain more generally, and where the gaps are in technology adoption. In some cases, the technology already exists, and either is not used or is underused, and in other cases the technology has the potential to be applied and benefit the sector, however it hasn't been observed yet.

1. **Human technology** is used to ensure behaviour does not deviate around the systems and processes in place in construction. Examples include:
 - ID tech such as ID passes for controlled entry, workforce movements and automated timesheets. These are common in almost all other sectors (and though had an increase use during COVID-19) are only present on the most secure or largest construction sites
 - location technology such as fixed cameras and sensors operating on

- sites that automatically capture people moving into restricted areas - in warehouses, crane lifting zones, excavated trenches etc. – and alerts the work team. These are widely available and used overseas, and becoming more prominent in Australian construction.
2. **Plant and equipment technology** is used to improve the safety and efficiency of our operating plant and equipment in construction. Examples include:
 - automated excavation and transport, rail track maintenance exists in mining and rail sectors, construction works, and sensor safety
 - proximity sensors for other people, plant, and obstacles as well as load and flow sensors are underutilised in construction and warehousing
 3. **Process technology** is used to automate manual processes that tie down people's effort, cause delays in information flows and inaccuracies or incomplete information. Examples include:
 - common data environments to house data and information from various disciplines to improve coordination and collaboration. These are increasing in use in the design and engineering space, but lacking in project management.
 - Machine Learning / AI assist by processing data to provide insights and support data analytics. These are often used in logistics and finance but rarely in construction outside sophisticated program assessments.
 4. **Product technology** is used to identify and track products across the supply chain to reduce handling, loss and damage. Examples include: digital tags to identify and handle products readily through the stages of manufacturing and construction.

Skills and Training

Participants in the construction industry have limited exposure to technology during their education or on the job experiences, unless they pursue specific technology skill pathways. This has resulted in a culture of technology being perceived as daunting. The traditional pathways for the construction workforce do not incorporate technology in training, particularly for participants in the small residential sector of the industry. This leads to a lack of knowledge and awareness of Construction Tech and has contributed to low levels of adoption of technology.

A challenge is the complexity and diversity of the sector, with participants ranging from SMEs with a relatively small turnover to tier 1 companies with turnovers in excess of \$1 billion. The relevant digital technologies for these two types of businesses and the capacity required to establish and operate the digital solution is vastly different. As such, the skill requirements for these two businesses differ substantially.

In addition, different workers within a single business entity require varying levels of digital skills depending on their responsibilities. Some workers will be responsible for installing and maintaining digital solutions, while other will operate the equipment, and some workers will be beneficiaries of the digital solution with no hands-on responsibilities.

Skill shifts in the economy are increasing the demand for life-long learning; the traditional, front-loaded education model does not necessarily equip workers with all the skills that they will need throughout their career. One of the many areas in which this has manifested is in the uptake of digital technology, particularly for connectivity-enabled technologies, across the construction sector. This is a sector-wide issue, but most keenly felt outside of major cities and within SMEs.

A secondary issue of a lack of knowledge of the technologies available and how they can benefit the business is present in the industry. This gap appears to

mirror digital skills as it is largely found within the smaller residential

construction sector. While some may have high-level understanding of project management or accounting platforms, beyond that, knowledge as to what can be adopted is limited. This can be attributed to skill gaps, however, you don't necessarily require a high level of digital skills to realise the efficiency that digital solutions can deliver.

CASE STUDY: early career independent builder

Matt has just started out being his own independent builder. He has worked for a builder for a few years as carpenter by trade and has completed his Certificate in Building. He is in his early thirties and is technology aware and looking to create a business, disrupt the older generation by being nimbler, customer centric and using technology.

John is looking to leverage technology as a differentiator and is unsure of where to find it. During his certificate of building and his trade course, he wasn't shown any technology or taught on technology so he is uncertain of what's available and what he needs. He would like advice and guidance on what technology exists and what solutions would be the best fit for his business.

While the knowledge gap is naturally filled as the construction community shares information on technologies that increase the competitiveness of the business, this approach to adoption is slow, does not occur universally and result in a continuous lag.

Digital technology is used in many industries as an effective training aid. Online learning has accelerated over the past decade and COVID-19 has further accelerated the adoption of online learning.

Industries such as mining use online training as a means to undertake induction and ongoing training of their workforce. The use of digital technology is also used as a learning aid to train workers in high risk activities. For instance, working in an actual mining environment provides only limited real-life opportunities, while virtual reality training can expose the workers potential

hazards that can occur in a mine without the associated risks.

the market and over-paying for technology during the 'early adopter' phase. Alternatively, waiting it out risks becoming uncompetitive in the market.

Investment and Collaboration

In comparison to the size and relevance of the construction industry to the Australian economy, investment in technology is relatively low. While it has been shown that the adoption of technology can greatly improve margins, the industry is yet to realise the opportunity and gains that technology is able to provide. This results in further impacts to the industry including a lack of funding, incubation and young bright minds focussing on building local technology the industry needs to be competitive on the global stage.

Determining a strong business case for adoption of technology remains a challenge. For SMEs in particular, the investment required to take on technology (for example project management or estimating software), when the status quo works well and the advantages are not fully understood, is a significant undertaking. In addition, the business needs to obtain additional skills and resources to establish and maintain the technological solution.

Our youngest and brightest are choosing other paths rather than entering the construction industry or building technology for the construction industry, meaning we are forced to import solutions. Construction companies are missing out on precious productivity gains which can result in less lost time, resources and money and resulting in higher margins and higher levels of repeat work. Overall, the industry isn't moving forward as a group, leaving itself open for disruption from overseas. Many companies have recognised that the culture in the construction industry can be improved and have implemented cultural improvement programs to address this weakness.

The question that organisations appear to be asking is who will take the lead to move the industry forward. Innovation requires a degree of risk appetite in a sector where managing and reducing risk is an important factor in considering the viability of a project. For industry to pioneer, greater investment is required which could result in them pricing themselves out of

Businesses, government and industry representative bodies all have a role to play to help get over this hump of investment hesitancy and move the market to a point where SMEs are competing on the level of technical adoption.

Areas of further investigation

Workflow and Value Chain	Skills and Training
<p>Undertake a workflow mapping process for the construction industry, which identifies manual processes and potential areas of digitisation.</p> <p>Consider best mechanisms to communicate and engage with industry through peak bodies and other stakeholders to standardise data requirements for Construction Tech.</p> <p>Examine the benefits of an increase in change management capability and understanding on the people-impact of new technologies to see if this will achieve more successful investment.</p> <p>Examine governments' procurement arrangements and how they can provide investment security by specifying consistent technology demands across their large investment portfolio.</p>	<p>Explore how micro-credentialing and flexible learning opportunities can be integrated with traditional multi-year qualifications.</p> <p>Consider mechanisms for enabling regular engagement between the industry and education providers to align learning outcomes with industry needs, including a common framework and taxonomy.</p> <p>Examine ways to communicate with those entering education and the careers and opportunities open to them in the industry if they pursue training in digital technology.</p> <p>Examine incentives for those willing to train in the use of these technologies and increase appetite for risk in contemplating the adoption of new technologies.</p>
Technology adoption and gaps	Investment and collaboration
<p>Examine the benefits of a gradual increase in technology uptake by organisations and how this may yield more frequent successful outcomes than large drastic investments.</p> <p>Examine how industry can share the lessons learnt in investment for the sector's mutual benefit, rather than adopting a market protection position.</p> <p>The full economic value of the adoption of Construction Tech should be considered in future research as part of a tech audit, including identification of currently available technologies, their role, the barriers and benefits, broken down by subsectors.</p>	<p>Further work to fully understand the business case for adoption is required</p> <p>Explore the need for government funding in the forms of grants and seed investment to enable teams to generate new businesses targeting the industry.</p> <p>Consider creation of a hub and spoke innovation centre model for the construction industry with city centre spaces and regional roadshows.</p> <p>Examine options for Construction Tech accelerator program in partnership with industry with agreement to pilot/purchase/invest</p>

The Role of Government

States, territories, and the Australian Government can play a key role in leading the digital transformation of the construction industry, including driving digital adoption via standards, procurement policies and supporting partnerships with industry and training providers.

Governments are coordinating their individual approaches through forums such as the Board of Treasurers BIM working group and the Australasian BIM Advisory Board. Groups such as these have the ability to assist driving change, with a total government construction spend in excess of \$200b over the forward estimates. It is encouraging that these groups are converging in their approach to the development of policies rather than diverging. They are also looking at jurisdictions domestically and international for lessons learned.

The role of the Australian Government

The role of the Australian Government is to lead the normalisation of digital skills through the vocational and higher education systems, providing undergraduate and post-graduate courses that provide a pipeline of job-ready graduates capable of digital modes of project delivery.

As the asset owner of some of the nation's critical infrastructure, the Australian Government also has a role to play in reviewing and modernising its lease agreements for Commonwealth assets, such as airports. Prior to COVID-19, the five major Australian airports were spending more than \$2 billion annually on new and existing assets. With agreements that guarantee a return on capital, the incentives for airports to innovate and adopt processes and technology that reduce capital expenditure is diminished significantly.

Digital and data tools are capable of unlocking significant productivity gains and efficiencies. Construction has one of the slowest adoption rates of technology across the Australian economy. Infrastructure Australia is encouraging government and clients to move from a digital by exception to digital by default approach. The initial focus should be on policies, skills,

standards and approaches. Data should be shared, reused, structured, open and valued. Smart capabilities should be enabled upfront and should be repeatable.

The role of states and territories

The role of state and territory governments is to provide clear objectives and requirements for new infrastructure by leveraging international good practice for data standards and information exchange, such as ISO19650 - *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)* and ISO8000 – Data Quality.

State and territory governments must place higher value on digital approaches for infrastructure delivery and the benefits its adoption provides across the asset lifecycle. By articulating clear objectives and providing a competitive tension in procurement process, governments can create the right environment for the construction industry to adopt a digital way of working on infrastructure projects.

States are progressively doing their bit to foster a culture of innovation. We are seeing the organic adoption of new technologies in state government infrastructure projects. These projects have long lifecycles and complex operational and maintenance needs. For example, the education sector is delivering vertical school buildings sprouting making better use of land resources, and modular construction. Transport is delivering highly complex rail and road assets also using digital and prefabricated methods.

Examples of state and territories managing this opportunity

QLD: The Queensland Government introduced principles for BIM implementation to facilitate the digital enablement of Queensland infrastructure in 2018 (Department of State Development, Manufacturing, Infrastructure and Planning Queensland 2018).

The Role of Government

NSW: Transport NSW published a Digital Engineering Framework in 2018 to consolidate disciplines from across the transport lifecycle for a consistent, structured and reusable data creation and maintenance (Transport NSW 2018). The New South Wales Government mandated the use of BIM for the North West Rail Link which was completed in 2019 (Morrisseylaw 2021).

VIC: The Victorian Government published the Victorian Digital Asset Strategy (VDAS) in 2019, a comprehensive guidance document aiming to improve the way Victoria's infrastructure is planned, delivered, operated and maintained through good information management (Victorian State Government 2019). The Victorian Government has now committed \$11 million over four years to implement VDAS and deliver good information management across Victoria's \$144 billion infrastructure pipeline.

In Australia's market, it is essential that the right conditions are created for the sector to fulfil its potential and maintain global competitiveness. There is support for stimulating and facilitating digital transformation through government intervention allowing government to take the lead in helping to move the industry forward.

Government as a client – mandate of Digital Engineering/BIM

The current state of Digital Engineering/BIM deployment is that large construction projects are of a level of complexity that the use of Digital Engineering/BIM makes sense.

SMEs may use the model developed by the architect/engineer when it is available but will not build their own as there simply isn't the value that exists. However, adoption at the large construction level is thought to bring with it a trickle-down benefit, allowing the rest of the industry to follow suit as greater adoption facilitates accessibility.

Government mandates should be staged and become more advanced gradually so the industry and ecosphere have time to develop.

Government as a regulator – national standards

There is still no national set of standards around technology adoption in construction. Reasons for the lack of a consolidated approach is fragmentation of the construction sector around the country, which makes it difficult to pass mandates at the Commonwealth level (DeCicco 2019; Karandikar 2019). The vast majority of industry professionals work for SMEs, many of which have their own vocabularies and their own sets of standards. (Biggs 2019)

The supply chain too is typically highly fragmented. Australia's public building projects tend to use the National Building Specification (NATSPEC) documents as guidelines (ABAB 2018, p.13). The release of the international standards ISO 19650, which was developed based on learnings gained from the UK experience, and ISO 16739, help facilitate a more consolidated approach marked by improved communication and data sharing.

As a sector that has to navigate a lot of standards, which can vary from state to state, the introduction of additional standards around technology use may be contested by industry participants. However, with a number of platforms available, and no standardised approach to digital use, construction companies often need to spend time learning how to use a range of different software.

This was perceived as valuable when examining government's role as a client of construction and infrastructure, as it is a means to standardise expectations around the technology platforms that should be used. In addition, looking at how contracts are rolled out, there may be scope to foster a more collaborative environment.

Broadband Coverage and Use

Key to the successful adoption and operation of digitally enabled construction sites is connectivity. At most large projects on metropolitan sites, construction companies will set up a Wi-Fi network. Commercial builders interviewed that operate in regional and remote locations such as in far north Queensland or regional WA do not seem to experience issues around connectivity. They seem to successfully using 4G or 5G networks where available.

Homebuilders however rely on available network coverage, which can present challenges in areas with limited or no network (e.g. the fringes of the metropolitan areas). One example referenced included the Redbank Estate development in North Richmond, NSW, where reliable broadband coverage was not available during development of the estate, meaning on-site use of digital platforms was difficult.

While connectivity is currently not identified as a significant issue for the construction industry, it is likely that the industry will experience connectivity issues as the adoption of technology accelerates. As experienced by the Australian agricultural industry, once the adoption of technology increases and machines become embedded with sensors and other connected devices, the need for reliable connectivity is required to utilise the full functionality of the machine or device.

Previously, poor connectivity could be resolved by postponing the task that required connectivity until you had sufficient connectivity. However, in the case of agriculture, for some machines to operate and realise their full economic potential, they require stable connectivity. The construction industry appears to be in a similar situation to that of agriculture. Currently, poor connectivity can be resolved by postponing the activity until you have

adequate mobile reception or you are back in the office and are able to connect to the office broadband. This challenge is more likely to impact SMEs undertaking projects on metropolitan fringes such as new housing development and regional or remote projects, both construction and infrastructure. In many instances, connectivity will be able to be resolved through investing in solutions, however, like other industries finding the correct solutions is often challenging for SMEs who are focussed on their core business, such as building homes.

Connectivity beyond construction

Connectivity is now a basic expectation along with water and energy. Although most industry participants associated connectivity with the build itself, moving beyond this, to the future of the building was considered important in facilitating the development of Australia's Smart Cities. Without good, reliable connectivity, this becomes a difficult task and it is considered important to integrate early into the construction process. The pandemic has reinforced the importance of broadband in homes to facilitate video meetings and work from home. However, a traditional mindset has resulted in some going back to face-to-face meetings following eased restrictions.

Cybersecurity

The biggest concern raised by industry in relation to connectivity is cybersecurity. Going digital, leveraging data and using a range of applications establishes cyber risks that can be hard to navigate. The more apps you have, the greater the need to monitor cyber security, which is an additional dimension in an environment that is already managing significant risks.

Broadband coverage and use	Role of Government and industry
<ul style="list-style-type: none"> ● Consider development of an Australian Construction Tech strategy to leverage the four key areas identified throughout this report to drive further take up of digital tech. The strategy could include: <ul style="list-style-type: none"> ○ the development and implementation of a communication strategy for the construction sector, including small businesses ○ a recruitment strategy to attract diverse skills to the sector, for example as outlined in the women in tech strategy ○ help identify Australian-owned Construction Tech that can be marketed and exported overseas ● Explore connectivity options in regional areas and how they can support Construction Tech solutions ● Explore opportunities to address construction in urban fringes where connectivity is yet to be established. 	<ul style="list-style-type: none"> ● Explore ways for governments as clients and asset managers to foster greater sophistication in the procurement process. ● Advance the integration of Construction Tech into government infrastructure (i.e. creating digital twins of government assets). To start, larger organisations are most likely to lead the charge as they have the resources and people to do this, but small businesses can be encouraged to follow. ● Consider the implementation of mandatory standards to streamline Construction Tech procurement across governments (states and territories, and Commonwealth). ● Explore ways in which industry can play a lead role in driving adoption of Construction Tech, including business-to-business partnerships and engagement with government and peak bodies.

Appendix A: 2017 Recommendations on Construction Tech

The 2017 report identified a number of potential areas that could be explored and actioned to elevate the impact of Construction Tech in Australia. Progress of Construction Tech since the 2017 report has been patchy and a more concerted, proactive, government-led approach is required to really build momentum. While Australia has not progressed far in Construction Tech, certain other countries are moving ahead, with more progressive approaches.

The following section outlines each of the previous recommendations and their progress in the last 4 years.

	Recommendation	Status explanation	Reasons why the recommendation hasn't been progressed	Current value
Standards	Industry to develop a set of standards around technology adoption and use, with support from Government.	There is no Australia-wide set of standards around technology adoption in construction.	Reasons for the lack of a consolidated approach is fragmentation of the construction sector and the country, which makes it difficult to pass mandates on a Commonwealth level.	The industry seems divided in relation to the mandatory implementation of standards. However, a standardised approach seems to be welcomed assuming that it doesn't encourage overregulation.
BIM Review	Conduct an independent review into the implementation of BIM.	BIM adoption is fragmented in Australia. Between 40 to 60 per cent of projects are estimated to have adopted BIM. Larger construction companies are using BIM routinely, while SMEs are yet to fully implement BIM into their standard practice.	There doesn't appear to be a consistent BIM mandate or strategy which is believed to be due to the construction landscape being fragmented across states, missing Commonwealth guidance. Contracting that aligns the interests of stakeholders using a collaborative, value-based process that spreads responsibilities and incentives between project owners and those involved in the delivery of construction projects hasn't been fully realised (although there is evidence that this is happening in pockets).	Rather than looking at BIM adoption independently, a more holistic approach/guidance related to Construction Tech is recommended such as a Construction Tech strategy that goes beyond BIM alone.

Co-working	Construction sector to establish a dedicated co-working space for Construction Tech start-ups, alongside a Construction Tech accelerator program	There is still no evidence of dedicated co-working spaces or accelerator programs for Construction Tech	There is no organisation or body championing this recommendation and, with a busy industry, it is easy to deprioritise.	Construction Tech co-working spaces or hubs are believed to be important to help achieve step-change in the industry's technological progress, although may not be seen as a priority across the sector.
Government led tech adoption	Governments to lead by proactively incorporating adoption of new technology for large infrastructure projects	<p>There are signs of governments leading tech adoption which is reflected in state-based guidelines such as the Victoria Digital Asset Strategy, the Digital Engineering Framework published by the NSW Government, or the Principles for BIM published by the QLD Government.</p> <p>There is no Commonwealth Government requirement.</p>	No central body championing technology adoption across State and territory borders means reliance is on States and territories to take the lead.	This is seen as important, but mainly relevant for larger construction players.
Fostering connections	Government and industry to support and expand events focused on identifying technology opportunities in the construction sector and connecting emerging companies with customers and investors.	<p>Events identifying technology opportunities are rare and not accessible for all.</p> <p>While there are conferences and other gatherings around Construction Tech they are still limited and predominantly attended by representatives of larger construction companies, those working in technology and subject matter experts.</p> <p>SMEs can find it difficult to attend the type of</p>	There is no Construction Tech leadership such as a Construction Tech peak body to drive this recommendation.	This is identified as important, given that a key challenge for Construction Tech is awareness.

		Construction Tech events currently available.		
Research collaboration	Provide additional support for collaborative research initiatives focused on Construction Tech.	There are very few Construction Tech research collaborations happening.	<p>The Australian Research Council provides Linkage Projects grants to support projects which initiate or develop long term strategic research alliances to apply advanced knowledge to problems, acquire new knowledge and as a basis for securing commercial and other benefits of research</p> <p>There are Linkage Projects grant in manufacturing but nothing around Construction Tech, but it is unclear why this is the case.</p>	Research collaborations are identified as important. It is believed that Linkage Projects grants could help connect academia and industry to facilitate the growth of Construction Tech in Australia.

Appendix B: Key Technologies in the Construction Sector

	Overview	Opportunity	Priority
Robotics	Significant advancements in robotics, well suited to the construction sector. But, uptake is still in its infancy in Australia outside of large construction projects. Aside from investment costs, industry skills are not advanced enough, and there is some concern around job loss as a result of adopting this technology.	Education (TAFE/Uni), Collaboration with tech companies	LONG-TERM
Artificial Intelligence (AI) and Machine Learning	The adoption of AI and ML is only at the beginning in Australia. This is partly due to the availability of data and skills available in Australia. Minimal data limits progress.	Education (TAFE/Uni), Collaboration with tech companies Develop a strategy to promote the sharing of data across the sector.	LONG-TERM
Pre-fabrication and 3D Printing	Although still representing a small proportion of the industry, gaining momentum in Australia, as a result of the Government focus on the opportunity to create affordable housing.	Opportunity within regional areas.	LONGER TERM
Drones	The benefits of Drones have been recognised, and construction has been the fastest growing commercial adopter of drones in Australia. Greater sophistication is still required to manage what is considered relatively complex technology effectively.	Education (TAFE/Uni), Collaboration with tech companies	LONGER TERM
Building Information Modelling	BIM adoption in Australia continues to lag globally and although incorporated into projects with greater complexity, its value hasn't been realised across the sector.	Public sector – as a client	MEDIUM-TERM
Digital Twin	The US is leading the uptake of digital twins, with significant investment across the Asia-Pacific region. Although still in its infancy in Australia, there is industry recognition that it is something that is coming.	Public sector – as a client	MEDIUM-TERM
Project Management and Estimating Software	Key for project management and referenced across all tiers of industry. Recognition of the benefits is clear, but investment at the lower tiers can be significant. Lack of uniformity across projects and/or organisations means that sub-contractors have to use a number of different platforms.	SMEs – education, information required	SHORT-TERM

Robotics

Robotics facilitates automation of processes. Key robotic technologies for the construction sector include Lidar Vision, robust cognition including people tracking, Regulation Technology, or Vision for

other safety related tasks (Australian Centre for Robotic Vision 2018).

Benefits of robotics: robotics has brought a broad range of benefits to the construction sector as a result of greater efficiencies, and therefore improved productivity. Tasks traditionally performed by labourers that are increasingly difficult to recruit for, such as brick laying or concrete pouring, can be performed more precisely, quicker and with less associated risks through robotics (Australian Centre for Robotic Vision 2018, p. 104-105).

Robotic and vision systems automate processes including site safety. They identify hazards through proximity readings, link these back to related data sets to facilitate appropriate responses (Australian Centre for Robotic Vision 2018, p.105).

Robotics adoption: The uptake of robotics in Australian construction is still in its infancy. While robotics is being increasingly leveraged into large construction projects, small to medium-sized projects haven't had the same level of adoption. One concern raised by organisations at all levels was around job loss as a result of a switch to automation. Nevertheless, future adoption of robotics in Australia looks promising.

Artificial Intelligence (AI) and machine learning (ML)

Advances in technology are leading to greater sophistication in construction robotics which are increasingly making construction 'smarter' through AI (Ellis 2020; Xu et al 2021). It is estimated that by around 2030, robotics in construction will have the ability to collaborate in mixed human-machine leadership teams through self-directed actions facilitated through AI (Australian Centre for Robotic Vision 2018, p.186).

AI describes the ability of machines to imitate human cognitive functions, leading machines to be able to problem-solve, recognise patterns and learn (Rao 2019). It is a data driven smart technology that uses software with algorithms to enable machines to make data-based predictions (Ellis 2021).

Machine learning (ML) is a subset of AI (the learning) that uses algorithms to learn from data without being programmed (Rao 2019). For example, machines can learn from data patterns that servicing is required after a certain period of time or use (Ellis 2021).

Benefits of AI and ML: the ability of AI and ML to learn from data brings significant benefits for construction as it facilitates automated improvement on a daily basis (Ellis 2021). This benefits workers, clients and the industry through improved safety, productivity or quality (Ellis 2021). AI and ML is great for demand planning and supply chain optimisation (The University of Adelaide 2021). It saves time, for example, through automated monitoring (i.e. for planning, servicing needs) or text mining in project documentation; while it facilitates safety through the application of deep learning related to road surveying, bridge inspection, or site operations, to name a few (Ellis 2021; Seong et al. 2017; Xu et. At 2021; Zhang et al. 2019). AI and ML further frees the workforce from monotonous duties providing space for those working in construction to focus on their expertise (Ellis 2020; Ellis 2021).

Adoption of AI and ML: The adoption of AI and ML is only at the beginning in Australia (Engineers Australia 2020). This is partly due to the availability of data and skills available in Australia. AI and ML require large amounts of data. The more data there is, the more accurate and effective AI and machine learning can operate (Ellis 2021). The Australian construction landscape is currently lacking sufficient data with many small and medium-sized businesses, but also large businesses, still having a long way to go in their journey towards digitalisation and technology adoption.

The data that is available, tends to lack integration. This causes a data disconnections that negatively impact the ability of AI and ML to be used effectively (Ellis 2021). Those working in the sector are already short on time and unless they clearly see the benefits, they are unlikely to invest time and resources into the necessary data integration (Ellis 2021). At the same time, there is a need to develop

the necessary skills to effectively utilise AI and ML. As a result the sector is still behind other sectors in Australia and globally (McKinsey 2018).

Prefabrication and 3D printing

Prefabrication, prefab or Design for Manufacturing and assembly (DfMA) is the fabrication of building parts away from the building site. For example, 3D printing can be used to prefabricate structural components such as concrete blocks off site independent from the end product (Engineers Australia 2021). It is perceived as a key opportunity to grow construction and affordable housing in Australia (Ellis 2020).

Benefits of Prefabrication: Improvements in quality through a reduction in error, given that machines are better at performing repetitive tasks with high accuracy. Prefabrication further allows for increased speed and cost efficiencies, alongside improved sustainability and work-zone safety in construction (PrefabAUS 2021; Steinhardt et.al. 2013).

The Australian Government recently invested \$28 million into Australia's prefabrication peak body (PrefabAus) to improve Australia's housing market through more affordable and more sustainable building practices. Prefabrication is estimated to reduce housing costs through a 40 per cent reduction in project delays, and facilitate more sustainable practice through 80 per cent less waste and 50 per cent less CO2 emissions associated with the building process (Mordor Intelligence 2021).

Furthermore, the benefits of prefabrication have been recognised within higher education, with the Melbourne School of Engineering looking to grow prefab market share from 5 per cent to 25 per cent by 2025, contributing to job creation and economic growth (Pursuit, University of Melbourne).

Prefabrication adoption: There is increased global interest in prefabrication, with the global modular market having an anticipated growth rate of 5.7 per cent. This is expected to grow to US\$107.9 billion in 2025 (Research and Markets 2020).

Likewise, prefabrication is gaining momentum in Australia. While it currently represents about 3 per cent of Australia's construction industry, the value of prefabrication is becoming increasingly understood across Australia and its estimated market share is 15 per cent by 2025 (Health and Crough 2018; Johanson 2021; Mordor Intelligence 2021).

Drones

Drones are used in construction to help automate site data gathering and processing. For example, drones can check and record the volume of concrete poured on sites. They can gather data from complex site structures including tall and inaccessible buildings.

Benefits of drones: Inspecting the progress of construction projects through drones is more precise, time and cost efficient. (Butler 2018). The cost savings associated with using drones in construction is significant, estimated at 30 per cent with the potential to rise to 60 by 2030 equating to up to \$1,340m (Deloitte 2020, p.6, 29). The use of drones further helps to reduce health and safety risks on construction sites by eliminating the need to physically access sites to gain data (Auav 2021; Peng 2018).

Drone adoption: Construction has been the fastest growing commercial adopter of drones in Australia (Deloitte 2020). It is estimated that around 580 businesses provide construction related services. However, the use of drones in construction can be complex. Those operating the drones need to know what data to collect while there needs to be capacity to effectively link the data from drones to the BIM. The BIM in turn needs to be connected to the Cloud and ideally to AI that helps analyse the data.

Building Information Modelling (BIM)

BIM is a digital form of construction and asset operations. It brings together technology, process improvements and digital information to radically improve client and project outcomes and asset operations. BIM is a strategic enabler for improving decision-making for both buildings and public infrastructure assets across the whole life cycle. It applies to new build projects; and crucially, supports the renovation, refurbishment and maintenance of the built environment – the largest share of the sector. (NATSPEC Construction Information Systems Limited 2021) Benefits of BIM: include improved communication, less on-site mistakes, improved productivity and sustainability:

- enhanced communication and collaboration: as multiple stakeholders can access and make real-time changes to models at the same time, which enhances collaboration across the supply chain.
- economic and social benefits: using BIM improves economic and social outcomes through reduced waste and more sustainable practice (Kelly 2021); as well as helping to reduce time in field allowing employees to gain an improved work-life balance.
- competitive edge: BIM is also recognised as providing a competitive edge in tendering and attracting staff.

BIM adoption in Australia is patchy: The Australian BIM adoption was described as varied in 2017, and continues to be fragmented in 2021. Small to medium-sized construction companies may use the model developed by the architect or engineer when it is available but they do not tend to have the capacity to build their own. This is because investment in this is not realised at this end of the market, and unless clients are paying, the financial outlay is too significant for the return.

A key driver for the adoption of BIM among Tier 1 and Tier 2 construction companies in Australia is governmental requirements. This is particularly the case in transport, infrastructure, and education or hospital projects (ABAB 2018). Globally, the use of BIM has increased significantly over the past decade. For example, Denmark mandated BIM for public sector projects from 2007, and Norway from 2009.

Digital twins

A digital twin is the digital representation of a built environment that incorporates interactions of people. It is an extension of static BIM models that represents assets through data from design, construction, operation and geospatial information (EY 2021; Langston 2021).

Digital twins collect and process data through sensors linked to the IoT and machine learning models that analyse and learn from previous data as part of an internet of abilities strategy (EY 2021; Langston 2021). The demand for digital twin technology is increasing due to the increase in IoT technologies available across all sectors. With rapid growth expected over the next few years. It is increasingly important for businesses to adapt to this technology or risk being less competitive ([How digital twin technology is transforming construction \(infrastructuremagazine.com.au\)](https://www.infrastructuremagazine.com.au))

Digital twin technologies collect robust data and create stronger knowledge exchange between designers and end-users. They communicate the analytics for effective monitoring and performance optimisation to ensure the realisation of expected benefits. (Langston 2021)

Digital twin adoption: innovation, advances in technology and global competition is driving the adoption of digital twins globally. It is estimated that the digital twin market size will have a growth rate of 42.7 per cent globally between 2021 and 2028, this is across sectors (Grand Review Research 2021).

Residential and commercial construction together with manufacturing, automotive, and transport are

playing a key role in the growth of the digital twin market globally (Grand Review Research 2021). The US is leading in the uptake of digital twins. (Markets and Markets 2021).

In the Asia and Pacific region, the digital twin market size is estimated to grow by 30 per cent by 2026 (Market Study Report 2021). This growth is driven by China, Japan, Singapore and India (Markets and Markets 2021; Market Study Report 2021). Singapore is investing USD \$73 million building digital twins of the city. India is investing USD \$1.2 trillion into smart cities in the next 20 years (Market Study Report 2021).

Project management and estimation tools

Technologies for project management and estimation in construction play a key part in the current digitisation of construction companies in Australia. There is a range of project management and estimation software available to the construction sector. This leads to different software requirements across different jobs, resulting in the smaller players who work across multiple jobs familiarising with a number of different platforms.

Inconsistencies in software requirements can result in inefficiencies as multiple systems need to be learned. This in turn can lead to resistance for change, as those in the sector are busy and reluctant to take on jobs with additional prerequisites.

Software such as Procore or Aconex provide a range of features which have been embraced by those working in the commercial construction space. However, they can be overwhelming for the residential construction market.

Overall, there are few end-to-end project management and estimation tools available, causing challenges for integrated collaboration across the sector. Those that are available have huge potential domestically and globally due to a range of benefits.

Benefits of project management and estimation tools: The use of project management and estimation tools help builders streamline their work and payments. This creates significant productivity gains.

The use of automated processes through project management tools saves construction companies a significant amount of time and money. Time those working in the industry can spend with their family and money they can reinvest into their business. It also reduces risks and disputes. There is currently a large amount of money being spent on disputes.

These are significant benefits for the sector, considering that a poor work life balance and financial concerns contribute to a high rate of mental health problems in the sector. However, the financial outlay associated with some of the more sophisticated platforms in particular, and a general lack of knowledge and awareness as to the opportunities available to smaller tier organisations in this space are significant barriers to use. Given the smaller players contribute significantly to the sector, in terms of value of work done, and workforce, it is worthwhile looking to ways in which uptake of project management software can be improved.

Construction Tech Collaboration

There is a growing Construction Tech community in Australia. Victoria, and Melbourne in particular, is believed to be fostering a particularly promising Construction Tech community, driven by the Victorian state government and local industry players.

The community now meets at construction conferences such as the 'Future of Construction Summit', 'Where the next generation of Prop Tech happens' or the 'International Conference on Computer Modelling and Simulation'.

Events targeting both the technology and construction industry, such as 'Design Built' or the PropTech pitch night hosted by Fishburner provide another platform to meet. Though these type of events tend to be more popular among Tier1 and Tier 2 construction companies.

Those operating in the residential building space, Tier 3, tend to be too busy to attend formal events such as conferences or pitch nights. They are more likely to take part in traditional construction gatherings such as those hosted by the Master Builders Association or the Housing Industry Association; or trade nights offering tool demonstrations, for example run by Bunnings or Mitre 10.

Accelerator programs: though there is no targeted accelerator programs for Construction Tech, there are cross-industry accelerators such as Muru-D, the High Growth Accelerator 2021 or River City Labs that provide support for Construction Tech start-ups. Tier 1 construction companies are further investing corporate funds into external start-ups and their own accelerator programs.

Research: there are some research collaborations around Construction Tech happening, but not many. One of the construction companies consulted for this research shared that they have been collaborating with universities on two different research projects, one focused on waste management and the other on site efficiencies. The project on site efficiencies runs data from the construction site through formulas to establish how effective the construction project has been and where there are opportunities for improvement. Similarly, the research collaboration on waste management identifies current wastage and opportunities for improvement.

The international specialist skills institute fellowship from the Victorian Department of Education and Training, which explored if BIM should be regulated in Australia (Karandikir 2019), is a rare example of Government funded Construction Tech research.

Those working in higher education believe that there is a lack of investment in collaborative Construction Tech research. In line with technology companies, they believe that there is a big opportunity to collaborate to facilitate further development, adaptation and integration of Construction Tech in Australia.

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