HATCH

Digital Futures – Research Report

The Digital Drift

Unearthing innovative opportunities for Australia's mining and mineral industry

Examining the current state and future opportunities of digital transformation and business innovation for capital projects in Australia's mining and mineral processing industry

Foreword

It is with great pride that we present this report on the opportunities for digital innovation in Australia's mining and mineral processing industry.

Over my twenty-five years of experience in the industry, I have witnessed teams of motivated people delivering exceptional projects. When we reflect on how projects were done just twenty years ago, it is clear the industry continues to improve. Historically, the industry has adapted to technology well. We sometimes forget that things that we now take for granted (i.e., 3D design, data-centric design, modularization, sophisticated planning, scheduling, and risk analysis) took quite some time to find the right value levers that technology offered and gain common acceptance.

When it comes to the more recent paradigm shift in digital technology that is impacting all economic sectors globally, the mining industry and the engineering and construction industry should be challenging themselves much more. Simultaneously, these industries should be increasingly tapping into the value that digital technologies promise.

This is not to say that examples of emerging innovative technologies in the industry do not exist. Take Rio Tinto's AutoHaul™ trains, for instance, which are often referred to as the world's largest robot. Or the large number of autonomous trucks that transport material in Australia's Pilbara region. Or the development of innovative plant control and automation solutions, which sit towards the top of the innovation spectrum when compared to alternative asset-intensive industries. But these examples are the exception rather than the norm.

As this report reveals, the penetration of digital innovation into capital projects and throughout the industry ecosystem in a holistic and connected way remains much shallower than its potential: a huge amount of value that is currently available is being left on the table. In this regard we could argue that the industry still has plenty of room to grow, and, more urgently, that it cannot afford to fall behind.

We are confident that the deep insights and detailed recommendations presented in this report will provide significant value for all industry stakeholders, and even those in other industries looking to learn from well-researched approaches. The report's recommendations will help to spur actionable pathways forward for business leaders seeking answers on what can be done today when it comes to advancing digital innovation and reaping the widespread benefits for growth, profitability, resilience, and sustainability well into the future.

I would personally like to thank all those individuals who participated in the research interviews for providing such nuanced perspectives, thoughtful ideas, and depth of consideration on this important topic. Enjoy.

Jan Kwak
Hatch Managing Director, Australia-Asia

Abstract

Globally, digital innovation has revolutionised the way we live and work. But not all industries and organisations have kept pace. Those that find themselves facing a digital gap have critical work to do not only to thrive, but to survive. This study offers in-depth insights into the current state and future opportunities of digital and business innovation for capital projects in Australia's mining and mineral processing (M&M) industry. Through one-on-one interviews with eighteen industry business leaders, several important findings emerged that confirm a hypothesis supported by other industry sources: Australia's M&M industry is still in its infancy when it comes to digital innovation in capital projects, with plenty of room to grow and a great deal of value to be realised. Through a closer examination of respondents' attitudes, perspectives, and barriers to adoption, the study presents a comprehensive set of recommendations for how to advance digital innovation successfully in order to capture and create value and build long-term business resilience and profitability. The study's recommendations are anchored by three pillars of success: leadership, vision, and strategy; people and culture; and technology foundations. This study is significant in that it is one of the most targeted primary research studies into the Australian M&M industry conducted to date. With these detailed recommendations and actionable paths forward, business leaders and industry stakeholders will have the knowledge and confidence to take the next steps in their journey toward a digital future.

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Introduction

Globally, the pace of technology-driven change is astonishing. It is transforming our lives, the way we live, the way we communicate, and the way we achieve even the most basic work activities. The influence of digital innovation has become so ubiquitous that its reach leaves no economic sector untouched, from retail to raw materials.

The role of digital innovation in heavy industries around the world has captured the attention of business leaders, operators, project managers, consultants, shareholders, supply chain participants, and financiers across the sector. But to what extent are digital technologies being adopted and embraced across these industries?

For Australia's M&M industry, the question we need to ask ourselves is this: are we riding this pivotal wave of change or sitting on shore watching the digital world wash by?

A quick look at the history and current state of the industry suggests a digital gap in which we are falling behind the curve. Yet it also betrays an industry with massive digital growth potential—one that is ripe for transformation.

The purpose of this study

The purpose of this study was to gain insight into the current state and future opportunities of digital innovation in capital projects in Australia's M&M industry. These important insights frame a collection of actionable recommendations that detail:

1. **Immediate benefits**: how business leaders and decision-makers can capture and create better value through digital innovation for all capital project stakeholders.
2. **Long-term benefits**: how the industry can position itself to take advantage of timely opportunities to secure long-term prosperity and reach its full potential in the increasingly digital-driven world of the future.

While this particular study's data is drawn from Australia's M&M industry, the findings and recommendations are relevant to those who work in a broad range of commercial-industrial, asset-intensive, advisory, engineering, and construction settings around the world.

Industry context

M&M and its associated supply chain is multifaceted and typically global in nature. It is the lifeblood of the world's economy, supplying the necessary raw materials for the manufactured products that we use in our day-to-day lives.

In Australia, "our resources sector is critical in maintaining our national prosperity, employing more than 247,000 Australians and generating $279 billion in exports last financial year. It is one of our great economic strengths and is the bedrock of communities throughout the country."[1]

Capital project development

The challenges associated with developing M&M assets have remained largely constant over the past thirty years. Developing and managing capital projects is still a complicated endeavour fraught with difficult decisions, challenging relationships, and a multitude of competing environmental variables and constraints.

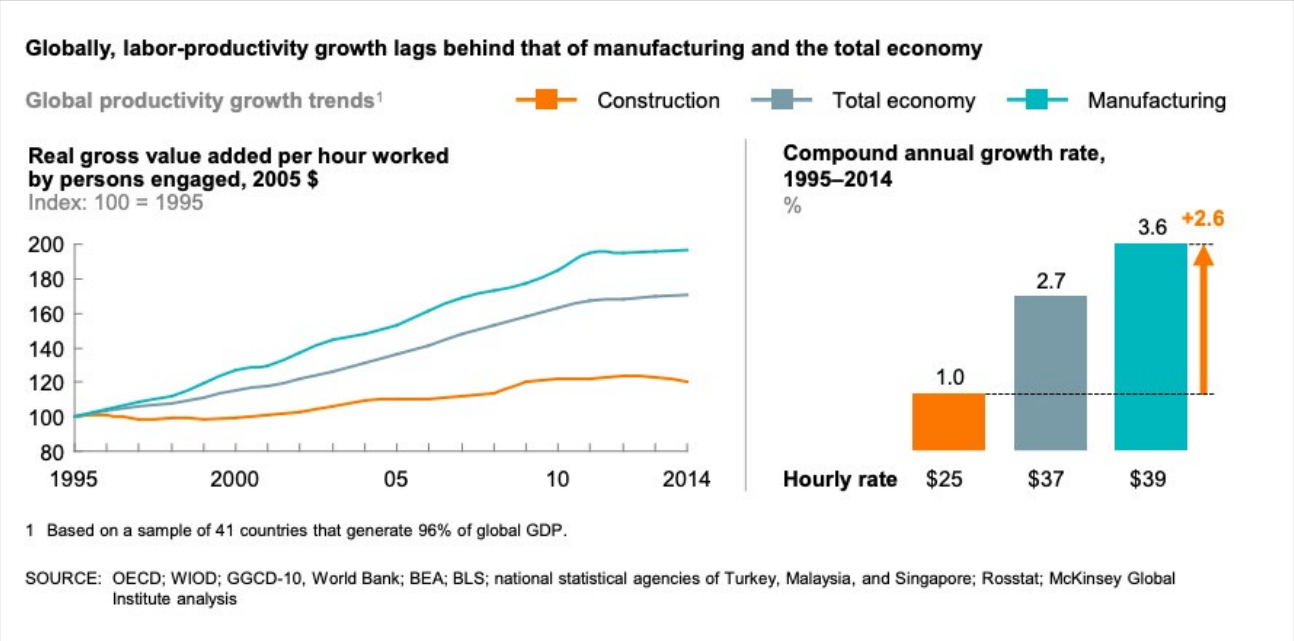
Historically, M&M organisations had internal capability to execute major projects. In contrast, market research confirms that all of Australia's major miners are now outsourcing most of their traditional services to contractors, and there are now thousands of vendors and subcontractors. Indeed, all the Australian M&M organisations surveyed in this study currently have relatively small internal project execution teams and rely on external parties to provide engineering, construction, and often project management capabilities.

The reasons for this divestment come down to the slowing of major capital project developments, the cost of maintaining an internal team, and the team not being core to the business. These factors are exacerbated by the cyclical nature of investment and the changing locations of project deliveries and sites around the world.

The result is a loss of project delivery expertise and organisational knowledge from the operating organisations and a heavy dependence on the execution capabilities of external suppliers.

Productivity

Other industries such as manufacturing have had a four times greater increase in productivity when compared to the construction industry over the last fifteen to twenty years. The graph below demonstrates the extent to which labour productivity growth has lagged behind manufacturing and the total economy from 1995 to 2014.



Source: McKinsey Global Institute, Reinventing Construction: A Route to Higher Productivity, February 2017

Industry-level assessments confirm a relatively stagnant growth in labour and capital productivity in the mining, engineering, and construction industries. A recent study by the Construction Industry Institute estimated that the impact of several project interface factors can accumulate up to 40% of cost inefficiency. These factors include a complex and fragmented ecosystem, ten-plus business tiers/layers, hundreds of contractual interfaces, compounding mark-ups and contingencies, and claims and disputes.

This highlights that a major opportunity for the M&M industry to improve is available through the development of a stronger commitment by the industry to reduce the level of fragmentation between the various parties in the project delivery ecosystem.

Digital technology

Over these past three decades, the impact of digital technology has been felt sluggishly and unevenly across different project functions, gradually evolving for some while remaining stagnant for others.

Construction Manager Magazine reports that the current level and rate of digital adoption is low, driven by the industry's cultural resistance to new processes and technologies.

Take, for example, the 3D modelling software AutoCAD, first released in 3D by Autodesk in 1994 shortly after the very first form of solids modelling software was introduced by PTC Cero in 1987. While this software is now ubiquitous across the industry and 3D modelling capability has improved significantly since it was invented, such digital technologies have had little impact on project delivery practices and capital productivity.

Elsewhere, in different but similarly complex environments like the financial industry, the opportunity to apply advanced algorithms for more sophisticated handling of large amounts of dynamic data has been heartily embraced for many decades. Hatch senior data scientist Ali Vazirizadeh notes "the financial industry has been using AI [artificial intelligence] and ML [machine learning] for almost thirty years to optimise and grow their business operations."

When it comes to M&M capital projects, certain inherent barriers to entry—long project duration, aversion to risk, high levels of capital investment, and large project teams—mean the industry has been insulated from disruption. As this study will reveal, combined with the loss of internal expertise, the resulting lack of ownership has left the potential of digital transformation an orphaned idea without a guiding hand to bring it to fruition.

As globalisation increases competition for the provision of raw materials, if M&M organisations want to survive and thrive as essential drivers of the global economy, they cannot afford to rest on their laurels when it comes to digital innovation. Furthermore, as Charles Darwin first observed of evolution—those who are slow to adapt can not only fall behind but go extinct. The time to act is now.

Methodolgy

This primary research study was conducted by Hatch to gain insight into the current state and future opportunities of digital innovation in capital projects in Australia's M&M industry.

The study's hypothesis was that digital adoption in capital projects in Australia's M&M industry has been limited to date.

Participants

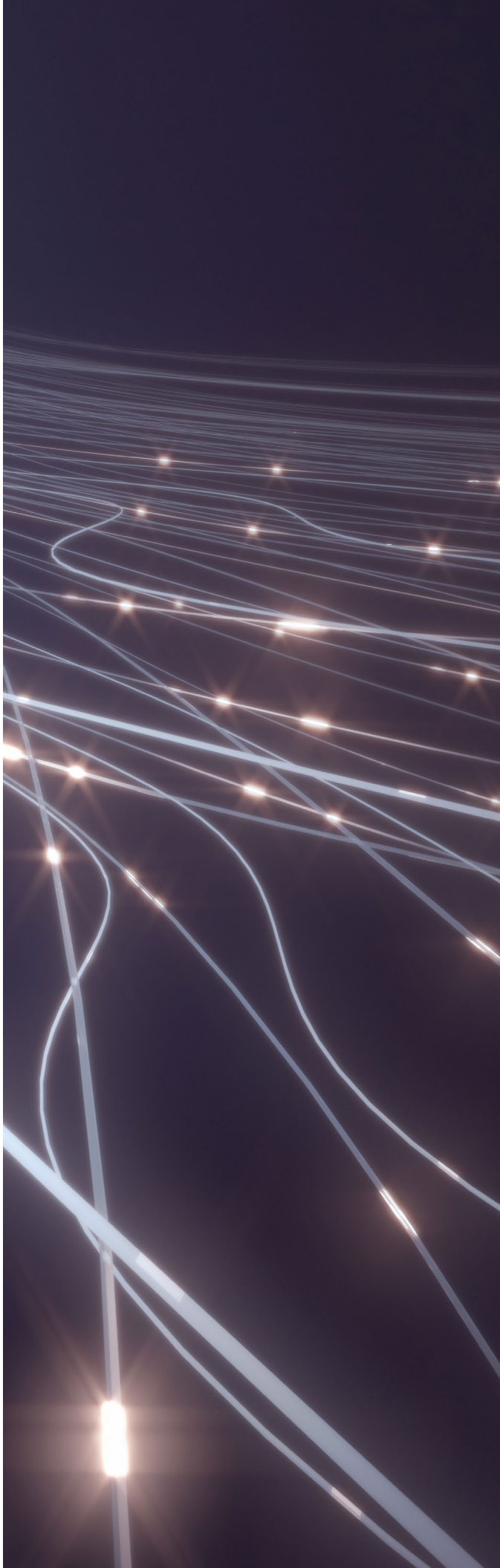
The study conducted in-depth interviews with eighteen leaders from Australian mining, engineering, and construction companies. All participants held leadership positions within their organisations and had broad responsibility for project delivery or project technology functions. Participants' roles are listed in **Table 1**.

Table 1 – Participant roles within their organisations

Role	Number of participants
Head of project group	7
Head of engineering	1
Chief information/digital officer	4
Project controls lead	1
Construction director/management	3
Productivity/innovation lead	2

Interviews

The interviews were held either remotely by teleconference or in person between November 2019 and January 2020. The interviews comprised a total of seventeen questions and were allotted a duration of sixty minutes.



Questions

The study's seventeen questions are listed in **Table 2**. Of these questions, nine were closed questions to enable quantitative analysis, and eight were open-ended to capture a more elaborate understanding of participants' attitudes and perspectives. Questions were designed to cover four topic areas related to digital innovation in capital projects: general, project methodology, project performance, and digital strategies and technologies.

Table 2 – Interview questions

Question number	Question	Open or closed	Answer options	Topic area
1	Historically, how have you met budget/schedule targets on projects?	Open		General
2	What best describes your project delivery approach/ contracting strategy?	Closed	1. Singular approach 2. Varied approach	General
3	Is the project delivery function centralised or commodity-focused? Does the project delivery function deliver new capital and sustaining capital projects?	Closed	1. Centralised 2. Regional 3. Commodity-focused	General
4	Have you deployed new or innovative partner/ supplier models and have you found them more/less successful?	Open		General
5	Do you have internal and/or external project benchmarks for project delivery performance in place?	Closed	1. Yes 2. No	Performance
6	How would you describe your experience with continuous improvement/delivery excellence programs?	Open		Performance
7	What five initiatives have delivered the greatest improvement in capital project performance/ management?	Open		Performance
8	Do you measure and/or benchmark post-project performance? I.e., operations readiness/ramp-up effectiveness?	Closed	1. Yes 2. No	Performance
9	Have you created analytics and predictive metrics (on projects) to support project managers?	Closed	1. Yes 2. No	Performance
10	How mature is your corporate capital project delivery methodology? Has it been updated to align with new digital tools/applications?	Closed	1. Not updated 2. In progress 3. Updated	Methodology

Question number	Question	Open or closed	Answer options	Topic area
12	Is there a corporate/enterprise set of project delivery systems? Do these systems cover the execution of suppliers' activities?	Closed	Part 1: 1. Enterprise 2. Project-specific Part 2: 1. Yes 2. No	Digital
13	What best describes the development of a specific capital projects digital strategy for your organisation?	Closed	1. Documented and embraced 2. Documented but not embraced 3. No digital strategy	Digital
14	Does the organisation have a digital team dedicated to a project or is digital support provided from a central function?	Closed	1. Dedicated 2. Centralised	Digital
15	What has been the investment in BIM (4D, 5D, etc.) and/or digital twins (virtual representation of the physical)?	Open		Digital
16	Is a defined strategy in place regarding mobility? (i.e., connected worker, RFID, etc.)	Open		Digital
17	How would you rate your level of digitisations on projects? Are you using technologies such as blockchain, VR, AR, and/or AI?	Open		Digital

Analysis

Both quantitative and qualitative analysis were performed on the study's raw data. Quantitative analysis of closed questions enabled graphical representation of proportions of participants who chose a particular answer. Qualitative analysis of open questions enabled the identification of commonalities, differences, and salient perspectives and attitudes in participants' responses.

Findings

The following findings summarise all participant responses to the seventeen interview questions. Responses have first been summarised in an overview table (**Table 3**), followed by a more detailed summary of each question in question number order below.

The detailed summaries of responses to each question include a graphical representation of responses to quantitative questions, the brief overview of all responses to that question (also shown in the table), followed by a list of bullet points highlighting some of the most salient perspectives and attitudes that emerged in response to that question.

The results confirmed the study's hypothesis, that digital adoption in capital projects in Australia's M&M industry has been limited to date. The **Conclusion and discussion** section analyses and further summarises the findings to pull out a set of overarching research themes and discusses how these themes may be interpreted in a broader industry context.

Table 3 – Summary of findings

Question number	Question	Overview of responses
1	Historically, how have you met budget/ schedule targets on projects?	Respondents showed very little commonality on the degree to which projects have historically met budget/schedule targets. But there was general agreement that measuring and meeting those targets fell well short of the much broader and more nuanced range of metrics and targets that could be indicative of success on any given project at any given time.
2	What best describes your project delivery approach/contracting strategy?	100% of respondents said they had a varied approach to their project delivery/contracting strategy. Most respondents had a process to define the approach and the delivery model based on assessments of an individual project's risks and requirements. Approaches tended to vary based on the project size, type, and in some cases, phase, as well as a broad variety of different factors. The chosen approach was typically made early in the pre-feasibility and feasibility stages of a project.
3	Is the project delivery function centralised or commodity-focused? Does the project delivery function deliver new capital and sustaining capital projects?	Respondents generally said that major projects had a centralised project delivery function whereas smaller projects and capital-sustaining projects tended to be more regional or commodity-focused. While there was an even split between all three types for owner operators, 66% of service providers said they were commodity or industry focused. Service providers explained that a strong driver of the model they used was to align with clients.
4	Have you deployed new or innovative partner/ supplier models and have you found them more/less successful?	Several respondents cited a tendency for project teams to be conservative when it came to delivery models with a common preference to stick to more traditional ones, particularly for major projects and the biggest industry players. Most respondents tended to emphasise that the impetus for innovation should be focused on the relationships between teams and partners and how everyone works together rather than on delivery models. To this point, one respondent described the likelihood of success as dependent on how well you manage the model, which comes down to relationships.

Question number	Question	Overview of responses
5	Do you have internal and/or external project benchmarks for project delivery performance in place?	All respondents confirmed they use benchmarks, and most confirmed they use both internal and external ones. A range of external benchmarks were mentioned, the most frequent, cited by 53% of respondents, was Independent Project Analysis (IPA). Other external benchmarks included those from Deloitte, Project Management Institute (PMI), Oxford University Projects, PM+, Hatch, and other sources. Most respondents used their own historical projects as internal benchmarks.
6	How would you describe your experience with continuous improvement/delivery excellence programs?	Respondents described a wide variety of levels and types of implementation of continuous improvement/delivery excellence programs. While some were using well-defined programs, tools, and initiatives on a project-by-project basis, many simply referred to larger corporate improvement programs and a couple simply referred to it as an area of opportunity. The lack of commonality in responses indicated that there is little standardisation in the industry when it comes to continuous improvement/delivery excellence programs.
7	What five initiatives have delivered the greatest improvement in capital project performance/ management?	Respondents consistently cited one particular area for initiatives that has delivered the greatest improvement in capital project performance and management: people/relationship/cultural initiatives. Other types of initiatives mentioned include: digital/technology, integration, safety and readiness, and productivity.
8	Do you measure and/ or benchmark post-project performance i.e., operations readiness/ramp-up effectiveness?	Almost all respondents said they measure post-project performance: 64% said that it was a shared Key Performance Indicator (KPI) while 36% defined the KPIs as a project performance metric.
9	Have you created analytics and predictive metrics (on projects) to support project managers?	Generally, despite confirming that they saw the value of such things, respondents reported very minimal to no creation of analytics and predictive metrics or next-level KPIs on projects. Those that did report something described the efforts as being in their infancy. 61% of respondents said they were not using such things, 17% claimed they were investigating, 22% cited some project instances, and 0% had anything fully adopted.
10	How mature is your corporate capital project delivery methodology? Has it been updated to align with new digital tools/ applications?	While many respondents described their corporate capital project delivery methodology as mature or fairly/relatively mature, most respondents said they had not updated it or were in the process of trying to update it to align with new digital tools and applications. 11% of respondents said they had updated it, 61% said it was in progress, and 28% said they had not updated it.
11	Are all the execution processes and information/data requirements well understood and codified?	While respondents tended to think their processes and data requirements were well understood, they differed on the level to which they described them as codified. Many described them as being codified in a document-centric way (53%) while others described a more data-centric, workflow-based, and integrated way (47%). Several said they were not perfect and needed updating. There was a general desire for those that had not already to transition to a more integrated workflow-based system.

Question number	Question	Overview of responses
12	Is there a corporate/ enterprise set of project delivery systems? Do these systems cover the execution of suppliers' activities?	79% of respondents described the systems as project specific while 21% described them as enterprise. 92% of respondents said they did not cover suppliers' activities while just 8% said they did. There was a general desire or at least an interest in exploring the potential of a single-platform integrated approach, but many challenges in getting the suppliers, service providers, clients, and owners on the same page.
13	What best describes the development of a specific capital projects digital strategy for your organisation?	Most respondents described little to no development of digital strategies for capital projects. 72% said they had no digital strategy, 11% said they had a documented (not embraced) strategy, and 17% said they had an embraced strategy.
14	Does the organisation have a digital team dedicated to a project or is digital support provided from a central function?	78% of respondents said that digital support was provided by a central function, while 22% described it as project-dedicated. One respondent described what they believed would be an inevitable shift from technology being a "thing" to being a tool used by everyone and owned by project team leaders. Another explained that they can only see the requirement for digital growing in the future.
15	What has been the investment in BIM (4D, 5D, etc.) and/or digital twins (virtual representation of the physical)?	Respondents described a full range of levels of investment in BIM and digital twins from none to significant. Most reported being in the early stages of investment, particularly with respect to digital twins.
16	Is a defined strategy in place regarding mobility i.e., connected worker, RFID, etc.?	Most respondents either had no defined strategy or were thinking of trying out mobility technologies and practices in an ad-hoc or adopt-and-adapt manner with no centralised or consistent approach. Two respondents described a well-established mobile strategy using RFID tags, one of which said the technology has driven value for operations in terms of safety and asset management. Another said they are working on incorporating these elements into a wider digital strategy focused on capturing data more effectively, and they see the benefit for productivity.
17	How would you rate your level of digitisations on projects? Are you using technologies such as blockchain, VR, AR, and/or AI?	Respondents varied in the degrees to which they rated their levels of digitisations on projects from low to high. Most respondents indicated that where they were using advanced technologies like blockchain, VR, AR, and AI it was generally on an ad-hoc basis or being trialled but not being fully committed to yet. 12% of respondents confirmed they had adopted all leading technologies, 35% were trialling on projects, 41% were investigating, and 12% were not considering.

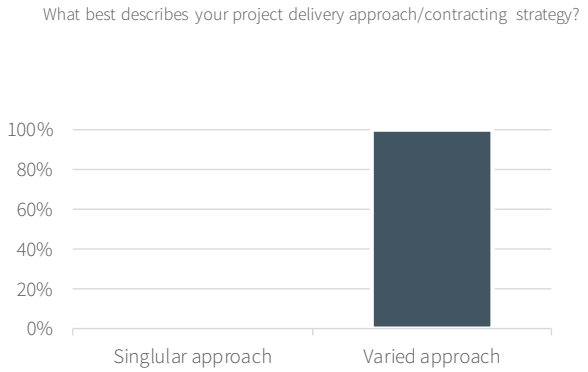
Question 1:
Historically, how have you met budget/schedule targets on projects?

Overview of responses: respondents showed very little commonality on the degree to which projects have historically met budget/schedule targets. However, there was general agreement that measuring and meeting those targets fell well short of the much broader and more nuanced range of metrics and targets that could be indicative of success on any given project at any given time.

- **Wide range of variance on meeting budget/ schedule targets**: of those who answered with quantifiable percentages, a broad range of averages were cited. Everything from being under budget and within schedule to being within 5% to 10% of those targets, to being within 25% of those targets.
- **Project phase matters for measuring and meeting budget/schedule targets**: one respondent claimed that in the study phase it is a lot easier to deliver projects as the focus is on assessing technical options and divergent solutions to achieve a capital risk return profile that is commensurate with the business' requirements. Another respondent said that budget and schedule metrics were only relevant once the project achieved its performance targets, i.e., the actual benefits for which the investment was approved.
- **Relevant targets go well beyond budget and schedule**: most respondents said that while budget and schedule adherence was important, a much broader set of metrics and targets were important for assessing the success of any given project. Respondents emphasised that different targets are needed for different types of projects, different clients and partners, and different stages in the life cycle of a project. Such targets respondents mentioned included: performance against project benefits promised, predictability, efficiency, business value, nameplate capacity, safety performance, net present value (NPV), toll gate performance, the customer view of success (tangible and perceived) and customer satisfaction, technology/support function, environmental and social license performance, quality, value earned at the right rate, turnover ratios and culture, training adherence, and cashflow adherence.
- **Other success factors**: some respondents cited other success factors in the process including the development of early-stage divergent solutions and integration of teams and processes through delivery and ramp-up.

Question 2:
What best describes your project delivery approach/contracting strategy? *(Answer options: 1. Singular approach 2. Varied approach)*

Overview of responses: 100% of respondents said they had a varied approach to their project delivery/ contracting strategy. Most respondents had a process to define the approach and the delivery model based on assessments of an individual project's risks and requirements. Approaches tended to vary based on the project size, type, and in some cases phase, as well as a broad variety of different factors. The chosen approach was typically made early in the pre-feasibility and feasibility stages of a project.

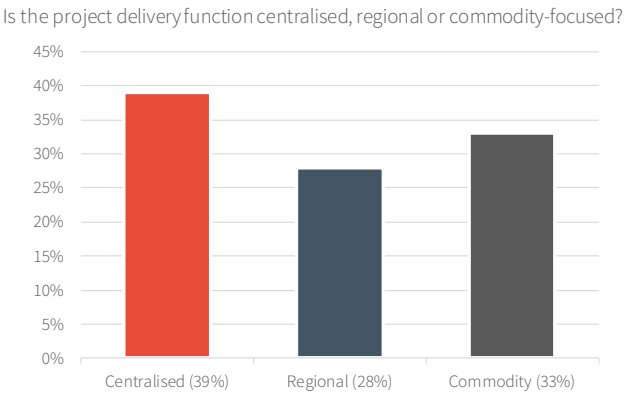


- **Major dimensions along which project delivery approaches vary**: project size (mega, asset-level, minor), project type (traditional construction, technology), and project phase (development, execution). One respondent described a stage gate process by which projects had the flexibility to change in approach from one phase to the next (for example, the first two development stages might start with ECM while later execution stages would use an EPC model).
- **Risks and requirements considered in defining an approach:** complexity, how much detailed engineering has been done, teams and skill sets, priorities, budget and schedule constraints, knowledge, scale, impact, market and people availability, geographic conditions, and type of technology being applied.
- **Models mentioned**: respondents cited a range of contracting models used including EPC, EPCM, PCM, D&C, P&C, client management models including owner's team and integrated owner's team, as well as financial models including lump sum and reimbursable.
- **Attitudes to project delivery**: respondents revealed that business and project groups tend to be risk averse and there is a reticence to change in the industry. Despite believing every project is unique, people tend to like tried and true methods and three out of four times you define a model that is a variant of the previous project.
- **Next steps:** one respondent cited a need to get better at articulating the business case for the contracting strategy itself, while another felt that moving towards a more integrated approach to delivery, making better use of digital solutions (such as interacting via a common platform, getting more transparency and visualisations into what is happening across the entire value chain, and getting the right people involved earlier on), as well as having more trust in people was the right way forward. The vision was an integrated partnership type model—the walls are beginning to come down and there is a change from what has traditionally been a siloed approach, but in order to unlock the true value people need to share their information with each other.

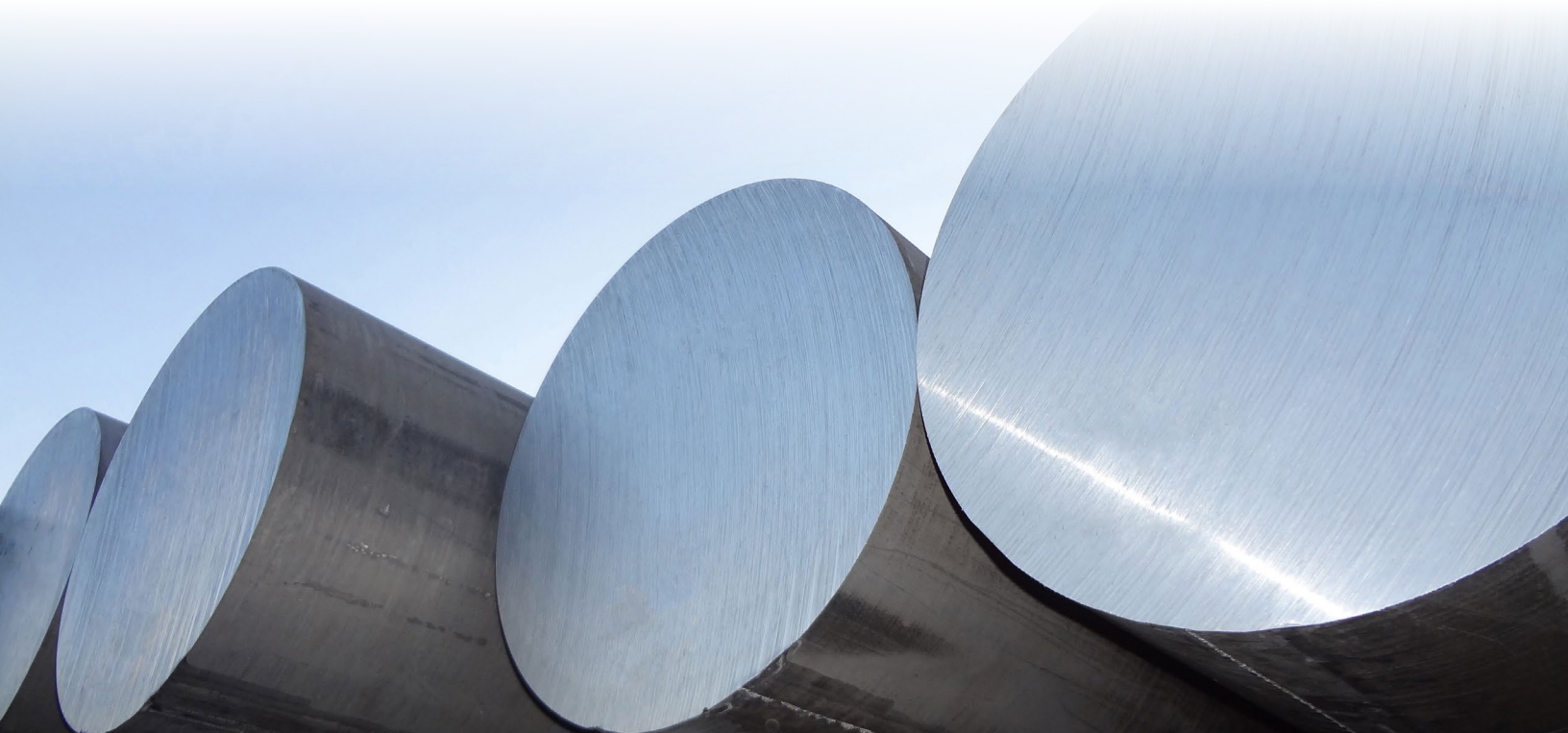
Question 3:

Is the project delivery function centralised, regional, or commodity-focused? Does the project delivery function deliver new capital and sustaining capital projects? *(Answer options: 1. Centralised 2. Regional 3. Commodity-focused)*

Overview of responses: respondents generally said that major projects had a centralised project delivery function whereas smaller projects and capital sustaining projects tended to be more regional or commodity-focused. While there was an even split between all three types for owner operators, 66% of service providers said they were commodity or industry focused. Service providers explained that a strong driver of the model they used was to align with clients.



- **Technology projects are delivered differently:** those that commented on technology projects described them as being delivered by a separate function within the business based on the recognition that they often follow a different project delivery methodology.
- **Many use centres of excellence:** in addition to having a centralised project group, several respondents confirmed the existence of a project centre of excellence, a centralised group that is responsible for providing good rules, tools, people, and systems support and governance, as well as centralised cost, schedule, and estimating functions. Within these centres there are generally different frameworks for major projects and asset or sustaining capital projects, but with overlaps to drive synergies and commonalities across the full range of projects.
- **Centralisations has been a beneficial transition:** one respondent noted the transition to centralisations they have made over the past six years has driven improvements across all projects.



Question 4:
Have you deployed new or innovative partner/supplier models and have you found them more/less successful?

Overview of responses: several respondents cited a tendency for project teams to be conservative when it came to delivery models with a common preference to stick to more traditional ones, particularly for major projects and the biggest industry players. Most respondents tended to emphasise that the impetus for innovation should be focused on the relationships between teams and partners and how everyone works together rather than on delivery models. To this point, one respondent described the likelihood of success as dependent on how well you manage the model, which ultimately comes down to relationships.

- **Traditional tendencies:** several respondents described the conservative nature of the industry. A shared sentiment was that project teams are not incentivised to be creative.
- **Uncertainty over what constitutes an innovative model:** several respondents also expressed uncertainty about whether what they were doing was innovative or not.
- **Innovative approaches:** a few respondents cited some innovative initiatives including technology development through a prototype, alternative framework agreements, an open book partnership with a technology partner, incentivised or gain sharing contracts, and crowdsourcing digital solutions. One respondent's global platform for crowdsourcing won an industry award and has delivered $10M of free cash flow for some (smaller) companies. Another respondent described their agile project development pathway based on principles rather than process, with greater flexibility and adaptability to allow the project to change form to better meet budget and schedule targets. Others offered up innovations they had developed in other areas, not in partner/supplier models but in processing technologies and the maintenance side of the business.
- **Barriers to innovation:** respondents noted several concerns that constitute potential barriers to innovation, including the capability of the industry to correctly understand each contracting model alongside an increasing preference for lump-sum fixed-price contracts which was attributed to a reduced level of experience in the contracting, procurement, and project delivery capabilities across the industry. In another vein, one respondent said when they have tried something different, for example technology development through a prototype, they got value out of it and it got the job done. The barrier is not that it is not successful, but that the nature of the process of setting up a project execution strategy tends to land on a model that is a variation of a previous (more traditional) one. Another respondent had trialled some innovative initiatives without any beneficial results or outcomes.
- **Opportunities for improving relationships:** respondents listed several areas in which relationships could be improved to deliver better value for projects, including earlier engagement with contractors, continuity of working relationships throughout the project life cycle, and generally moving away from delivery siloes towards a more integrated team approach that considers the whole life cycle. One respondent cited the importance of fostering a more collaborative approach to partnerships, information, and gain sharing in the development of more innovative approaches and solutions.

Question 5:

Do you have internal and/or external project benchmarks for project delivery performance in place?

(Answer options: 1. Yes 2. No)

Overview of responses: all respondents confirmed they use benchmarks and most confirmed they use both internal and external ones. A range of external benchmarks were mentioned, the most frequent, cited by 53% of respondents, was IPA. Other external benchmarks included those from Deloitte, PMI, Oxford University Projects and other sources.
Most respondents used their own historical projects as internal benchmarks.

Challenges of using external benchmarks: one respondent cited the challenges of using external benchmarking as the fact of it being difficult to find relevant examples that are directly comparable to any given current project.

Question 6:

How would you describe your experience with continuous improvement/delivery excellence programs?

Overview of responses: respondents described a wide variety of levels and types of implementation of continuous improvement/delivery excellence programs. While some were using well-defined programs, tools, and initiatives on a project-by-project basis, many simply referred to larger corporate improvement programs and a couple simply referred to it as an area of opportunity. The lack of commonality in responses indicated that there is little standardisation in the industry when it comes to continuous improvement/delivery excellence programs.

- **Corporate improvement programs:** respondents cited various annual or corporate improvement programs focused on areas such as safety, risk management, health and well-being, digital and technology, culture and engagement, and project delivery improvement. One respondent mentioned that all programs were assessed quarterly and annually and that this was rolled into PM+. Another said their annual reviews included improvements that were then fed back into methodologies, procedures, and controls. A couple of respondents described dedicated teams including an agile improvement team and productivity and innovation teams, as well as support networks to identify opportunities, provide tools, etc. One respondent described continuous improvement as a concept built into the culture of the organisations.
- **Project improvement initiatives:** several respondents mentioned using lessons learned as a way to drive improvements on projects. One respondent cited inflight reviews done on studies and projects in implementation. One respondent mentioned using IPA value improvement practices. Another cited the use of a range of technologies on one particular project (BIM 6D, full digital twin, iPads, GPS) to perform a six-month self-monitoring followed by a recommissioning based on this data. Another respondent mentioned they were in the early stages of developing a set of process close-outs to capture data to do better. Another mentioned a community-based living document in SharePoint for executive phase reviews, post-investment reviews, etc. Another respondent described a weekly check-in on projects and a monthly SteerCo check.
- **Challenges:** there was generally an expectation that suppliers or partners would bring innovation, and a corresponding disappointment when it was not found. A couple of respondents said they expected to see such improvement programs built into the EPC work plan or innovative approaches taken by the project managers, but were not seeing any evidence of it. Another challenge cited by two respondents was the reticence of projects or project managers to change once they were up and running. Finally, a lack of continuity or consistency of resources (i.e., turnover) on a project was cited as another barrier to implementing improvement programs as high-performing resources are not dedicated for five- to or ten-plus years.
- **Areas of opportunity:** one respondent cited the need for digital technologies to help optimise capital spend by integrating the value chain. Another encouraged the ownership of innovation by the project manager and their ability to operate autonomously.

Question 7:
What five initiatives have delivered the greatest improvement in capital project performance/management?

Overview of responses: Particular areas for initiatives that are consistently cited as delivering the greatest improvement in capital project performance and management are people/relationship/cultural initiatives. Other types of initiatives mentioned include: digital/technology, integration, safety and readiness, and productivity.

- **People/relationship/cultural initiatives:** a majority of respondents cited people, relationships, and cultural initiatives among those that have yielded the greatest improvements. These include initiatives related to people's well-being, the diversity of teams (i.e., gender diversity, diversity of thought), as well as improving the relationships between people and teams for smoother workflow, and improving the emphasis on better safety and productivity.
- **Digital/technology initiatives:** digital and technology initiatives were most often cited as an emerging area that could yield big improvements at some point in the future, but some respondents also expressed hesitation in this area and stressed that such initiatives needed to more robustly demonstrate value before being considered. However, one respondent spoke at length about the value of digital citing an enterprise reporting platform that delivers $10M in improvements each year already. That same respondent also mentioned the importance of automation and continuous learning for improving safety, decreasing costs, and increasing productivity. Finally, that same respondent identified that one of the biggest challenges to reaping the rewards of digital initiatives is the need to also invest in more digital education and getting people to use the digital tools.
- **Integration initiatives:** an integrated approach involves getting the right people involved, at the right time, with the right voice. Integration initiatives were mentioned by several respondents as delivering major improvements. This included different types of integration both across project stages (between delivery, ramp-up, and operations teams) and across current operations teams.
- **Safety and readiness initiatives:** respondents cited an improvement in safety performance as contributing to project delivery performance, and the importance of engaged, embedded teams to improve readiness which in turn contributes to better outcomes. It was also noted that operations teams need to improve digital capabilities.
- **Productivity initiatives:** respondents also cited the benefits of targeted initiatives to improve productivity. One respondent said that while reducing quantities in engineering helps, often the real wins are the billions of dollars of indirects related to construction.

Question 8:

Do you measure and/or benchmark post-project performance (i.e., operations readiness/ramp-up effectiveness)?

(Answer options: 1. Yes 2. No)

Overview of responses: almost all respondents said they measure post-project performance: 64% said that it was a shared KPI while 36% defined the KPIs as a project performance metric.

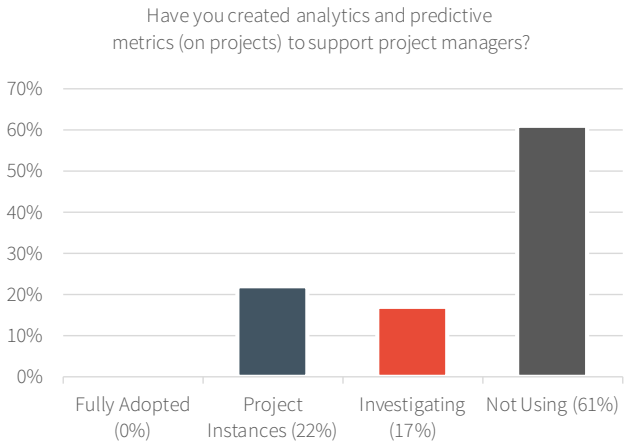
- **Shared KPIs:** many respondents described the post-project KPIs as being shared between the projects and operations teams.
- **Metrics used:** respondents described various metrics used including capacity and ramp-up performance, asset performance, capital productivity, meeting budget and schedule, engagement of site operations, and executing a proper operational readiness plan.
- **Timelines:** respondents cited a range of post-project performance timelines for measurement, anywhere from immediately after, to seven days after, to even one year after project completion. Some assessed performance at multiple points over time.

Question 9:

Have you created analytics and predictive metrics (on projects) to support project managers?

(Answer options: 1. Fully adopted 2. Project instances 3. Investigating 4. Not using)

Overview of responses: generally, despite confirming that they saw the value of such things, respondents reported very minimal to no creation of analytics and predictive metrics or next-level KPIs on projects. Those that did report something described the efforts as being in their infancy: 61% of respondents said they were not using such things, 17% claimed they were investigating, 22% cited some project instances, and 0% had anything fully adopted.



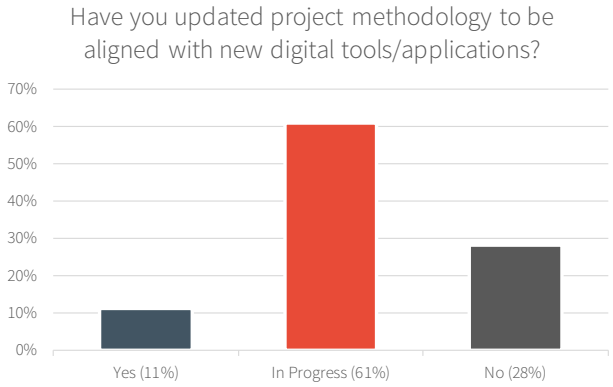
- **Barrier to adoption—data quality:** several respondents cited the problem of data quality and integrity as being a barrier to adopting more sophisticated analytics. One respondent said data libraries are not well structured, another described data cleaning as an important part of analysis, and another said that data needed to be in the right format and visualisations tools also need to be in place.
- **Barrier to adoption—scepticism over value added:** a few respondents explained that they were not using more advanced analytics to tell them something that a person could already tell them. One respondent said they had tried but found they were not getting better insights than their project services people could tell them. Another echoed this sentiment in describing their approach as expert-driven rather than analytics-driven.
- **Barrier to adoption—partner expectations:** several respondents claimed that they were looking for innovation from service providers or contract partners and were finding it lacking. One described this syndrome as an industry-wide issue. Another respondent expressed difficulty in moving into the digital age when workers on site were still asking for 2D drawings.

Next steps: many respondents said they saw the value of a more sophisticated approach and using predictive analytics, and one explained that while the solution is not a five-minute conversation, the conversation is happening.

Question 10:

How mature is your corporate capital project delivery methodology? Has it been updated to align with new digital tools/ applications? *(Answer options: 1. Updated 2. In progress 3. Not updated)*

Overview of responses: while many respondents described their corporate capital project delivery methodology as mature or fairly/relatively mature, most respondents said they had not updated it or were in the process of trying to update it to align with new digital tools and applications. About 11% of respondents said they had updated it, 61% said it was in progress, and 28% said they had not updated it.



- **Digital tools mentioned:** several respondents mentioned some digital tools they were either using, starting to use, or considering using, including Ecosys, SPMat, SP Suite, Procon, PowerBI, MS Azure, SAP, Ariba, and Aconex.
- **Updates being made or considered:** respondents were making updates such as developing automated reporting, accurate progress measurement, purchasing commitments, automatic integration, conveyor monitoring, digital twins, and improved control systems for safety management, data management, and financial package control. One respondent explained they were changing the way they did studies to consider what was needed to create a digital asset or to fully enable assets. Another was considering instrumentation, communication networks, and transactional applications to take full advantage of the data they already have in order to set up scopes to support projects that could deliver better digital insights.
- **Barriers to updating for digital:** a disconnect in understanding of the scope and capability of digital advances was mentioned by one respondent with contractors and suppliers: people who deliver projects do not think like operators. The respondent also described a tendency to create static models, not those that learn and change, and mentioned the problem of a plethora of siloed platforms provided by different suppliers as a challenge for integrating systems properly. Finally, this respondent described the confusion surrounding tools available in the market and lack of value being delivered by big platform companies that fail to target solutions appropriately.
- **Attitudes towards digital:** attitudes towards digital were mixed. Some respondents still questioned the value of making particular digital updates or going through the trouble of creating complex systems when they could just use contractors' and suppliers' tools. Others, however, saw the value and were actively trying to develop more digital sophistication. One respondent described the integration potential of the system as being able to greatly reduce the cycle time of implementing major changes (normally taking weeks or months to process) by 75%. Another respondent spoke at length about the dynamic digital twins they were creating for all sites, capturing the entire value chain using MS Azure.

Question 11:
Are all the execution processes and information/data requirements well understood and codified?

Overview of responses: while respondents tended to think their processes and data requirements were well understood, they differed on the level to which they described them as codified. Many described them as being codified in a document-centric way (53%) while others described a more data-centric, workflow-based, and integrated way (47%). Several said they were not perfect and needed updating. There was a general desire for those that had not already done so to transition to a more integrated workflow-based system.

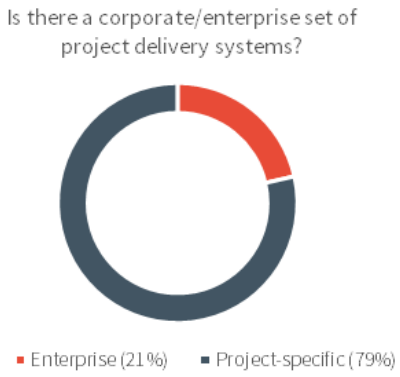
- **Defined processes and data:** for an owner, they provided design criterion, data, systems, and integration requirements, and a handover standard to the EPCM, leaving the rest to them, but would only hire those with a leading edge in digital systems. Others had study definition guidelines including workflows, forms, templates, and quick start tools. One respondent explained that their definitions were created to achieve an outcome rather than dictating the process to get there.
- **Flexible workflows:** one respondent had flexible guidelines where the project teams were expected to develop their own process flows and ways of working, and even their own preferred project delivery tools. Documents were only used to give a head start, but while they made some things quicker, the documents also hampered projects from adopting a data-centric approach, so the emphasis was on letting the team define their own approach.
- **Attitudes toward codification:** generally, respondents were in favour of updating their systems toward better integration and a workflow-based structure. One respondent recognised that codification was necessary because of the level of investment in the processes. In contrast, another respondent reported that project teams do not respond well to being forced into systems, while another thought that they had too many documents.

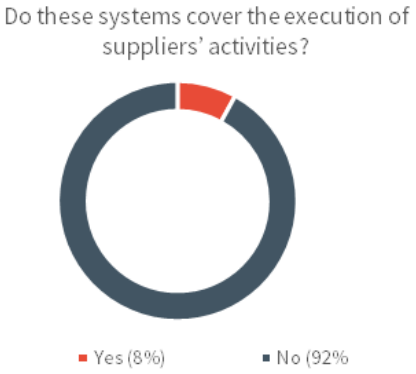
Question 12:

Is there a corporate/enterprise set of project delivery systems? Do these systems cover the execution of suppliers' activities?

(Answer options: Part 1: 1. Enterprise 2. Project-specific Part 2: 1. Yes 2. No)

Overview of responses: 79% of respondents described the systems as project-specific while 21% described them as enterprise. Further, 92% of respondents said they did not cover suppliers' activities, while just 8% said they did. There was a general desire or at least an interest in exploring the potential of a single-platform-integrated approach, but there are many challenges in getting the suppliers, service providers, clients, and owners on the same page.





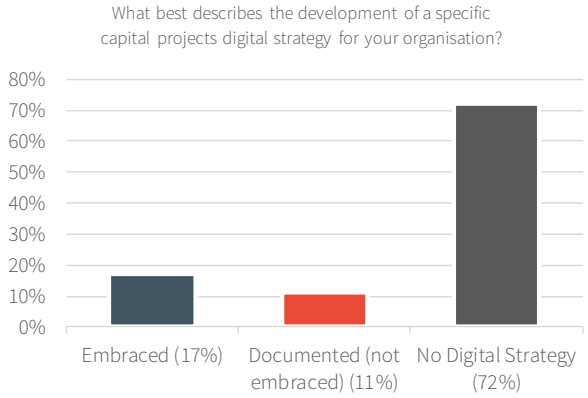
- **Attitudes towards ownership of systems versus system-agnostic approach:** one respondent reported that they felt as though they were funding a number of systems for their EPCMs without seeing enough returns. They believed that getting into design tools would remove the ownership, responsibility, and productivity from an EPCM. Another described conversations and studies in place to determine whether mandating or having agnostic systems was the better way to go, questioning what the limitations would be on a single global model. Another respondent described a goal of trying to be system-agnostic through a centralised platform.
- **Challenges for integration:** a respondent explained one of the biggest problems for integration was that every supplier has a different platform and customised tools, so in order to achieve full digital operations at sites you either have to pick a platform or have a neutral platform that pulls data from others, and with the latter the question was what level of intelligence do you lose through this central data aggregator? Other respondents echoed the problem of service providers' capabilities to present information in an appropriate form as well as the need for flexibility to cater to many different clients with different approaches. One respondent described the attitude or interest of the company's owner in data-driven systems and integration as low. Another respondent described hesitation to over-invest in a fully integrated suite of project delivery tools.

Question 13:

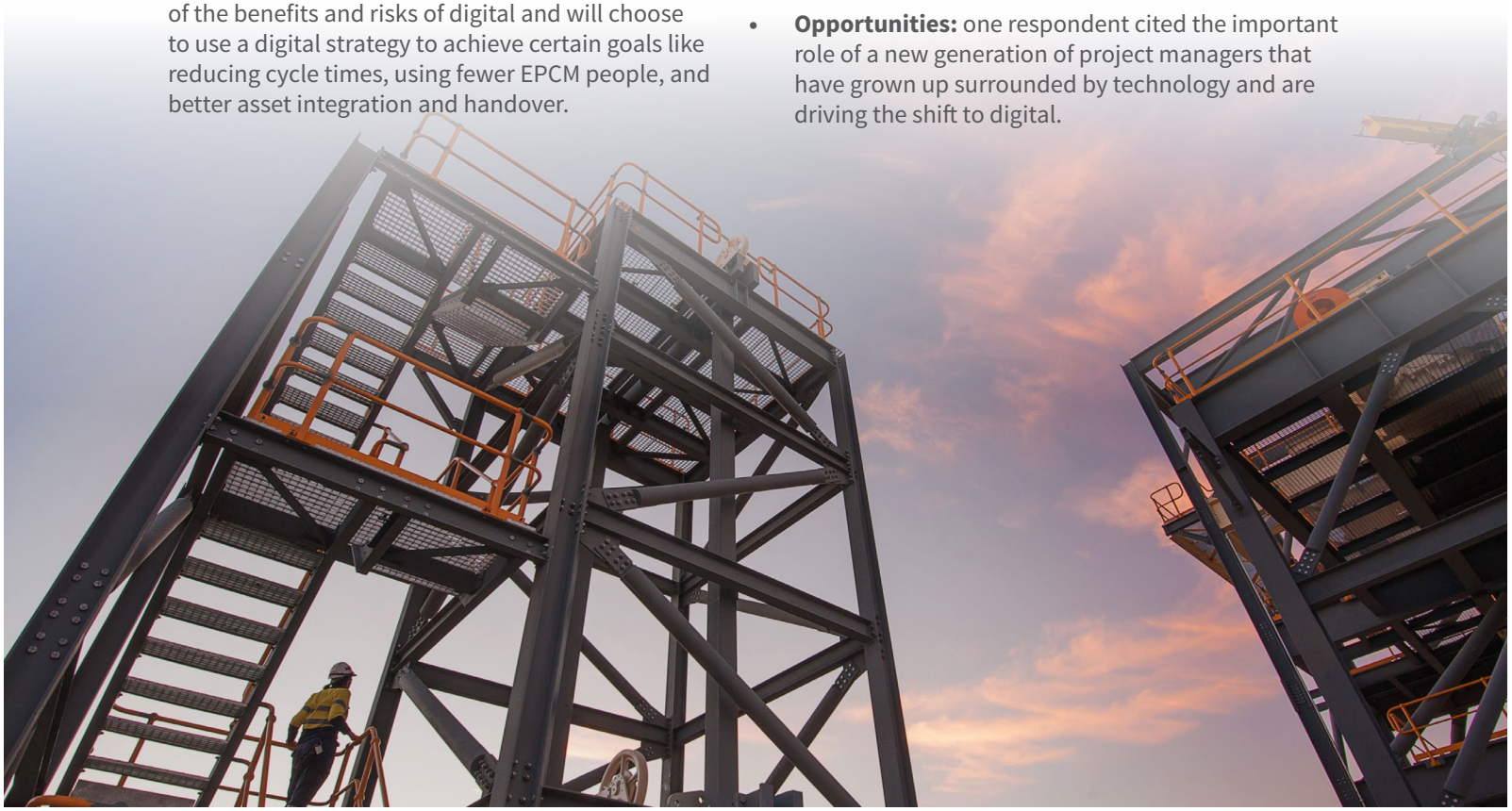
What best describes the development of a specific capital projects digital strategy for your organisation?

(Answer options: 1. Documented and embraced 2. Documented and not embraced 3. No digital strategy)

Overview of responses: most respondents described little to no development of digital strategies for capital projects. Approximately 72% said they had no digital strategy, 11% said they had a documented (not embraced) strategy, and 17% said they had an embraced strategy.



- **Barriers to adoption:** one respondent described being sceptical, noting that while they see the benefits, they cannot be quantified. Another respondent described the challenges of industry preparedness and getting all players on board. Another explained that they had people in the business who have done things a certain way for a long time, so there is a big change management component needed in shifting to digital.
- **People-first approach:** one respondent described an adopt-and-adapt approach, meaning that projects are driven by team members and enabled by technology, and a good project person is aware of the benefits and risks of digital and will choose to use a digital strategy to achieve certain goals like reducing cycle times, using fewer EPCM people, and better asset integration and handover.
- **Attitudes toward digital strategy for capital projects:** generally, respondents identified a more sophisticated digital strategy as a future goal for the organisation for which they understood the benefits and acknowledged the inevitability of a shift to digital more broadly. One respondent revealed that companies that invest now will have the biggest advantage.
- **Opportunities:** one respondent cited the important role of a new generation of project managers that have grown up surrounded by technology and are driving the shift to digital.

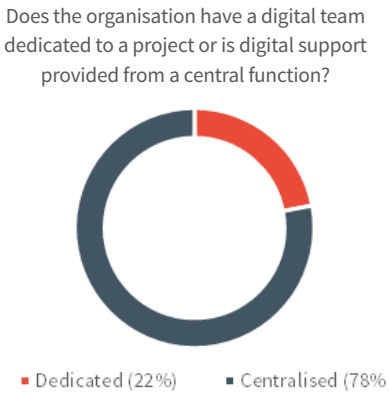


Question 14:

Does the organisation have a digital team dedicated to a project or is digital support provided from a central function?

(Answer options: 1. Dedicated 2. Centralised)

Overview of responses: 78% of respondents said that digital support was provided by a central function, while 22% described it as project-dedicated. One respondent described what they believed would be an inevitable shift from technology being a “thing” to being a tool used by everyone and owned by project team leaders.



Question 15:
What has been the investment in BIM (4D, 5D, etc.) and/or digital twins?

Overview of responses: respondents described a full range of levels of investment in BIM and digital twins from none to significant. Most reported being in the early stages of investment, particularly with respect to digital twins.

- **How to do it successfully:** one respondent said it was important to frame the investment in these technologies in the context of an overall digital strategy from an operations perspective, and that the rest of the asset needed to be up-to-date in order to derive value from these technologies. The respondent also said that the potential of digital when considered in the early stages was a relatively small investment.
- **Approaches to adoption:** one respondent described a project-by-project approach to investment. Another described the collaborative involvement of engineering and construction companies in the design environment. Another said they had hired a full-time data scientist to work on such things. One respondent said they had already implemented a virtual reality room with Synchro-4D to optimise schedule activities and present a visual representation to workers before they get to the site. This same respondent described investing in their own people to up-skill them on these types of technologies.
- **Barriers to adoption:** barriers mentioned included a lack of understanding of how BIM was different from digital twins, the lack of a standard delivery model in the industry and thus the problem of dealing with constant change, the uncertainty as to the ultimate value of such things, practical challenges such as missing aspects, a lack of uniformity across sites, and the lack of support from drafters and operators to maintain the data.

Question 16:

Is a defined strategy in place regarding mobility (i.e., connected worker, RFID, etc.)?

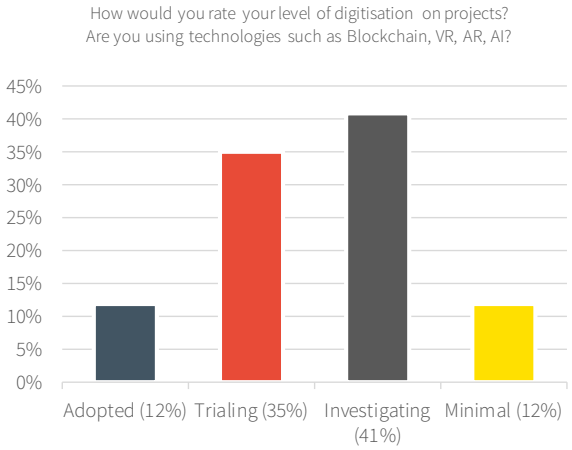
Overview of responses: most respondents either had no defined strategy or were thinking of trying out mobility technologies and practices in an ad-hoc or adopt-and-adapt manner with no centralised or consistent approach. Two respondents described a well-established mobile strategy using RFID tags, one of which said the technology has driven value for operations in terms of safety and asset management. Another said they are working on incorporating these elements into a wider digital strategy focused on capturing data more effectively, and they see the benefit for productivity.

Barriers to adoption: several respondents questioned the value or emphasised the need for demonstrable value before considering such things. One respondent also noted that the value may be there but if it was challenging to quantify there could be a missed opportunity. Another respondent pushed the responsibility for this to the service provider, explaining the challenges of being able to sort through the gimmicks to find the value. This respondent also cited the challenge of variable connectivity in remote locations for using RFID technology. One respondent, while they acknowledged the value of mobility technology and sensors that could eventually enable artificial intelligence applications, said they are currently better served by expert advice.

Question 17:

How would you rate your level of digitisations on projects? Are you using technologies such as blockchain, VR, AR, or AI?

Overview of responses: respondents varied in the degrees to which they rated their levels of digitisations on projects from low to high. Most respondents indicated that where they were using advanced technologies like blockchain, VR, AR, and AI it was generally on an ad-hoc basis or being trialled but not being fully committed to yet. About 12% of respondents confirmed they had adopted all leading technologies, 35% were trialling on projects, 41% were investigating, and 12% were not considering.



- **Technologies in use:** several respondents said they were using VR technology. One, for local communities to show them what will be built. Two respondents said they were using HoloLens to run management teams through the plant. One respondent said they were using machine learning and AI "extensively" including everything from machine vision to tell what asset you are looking at, to Watson for cognitive intelligence. Those respondents who said they were using machine learning and AI said it was being used more widely in operations with limited implementation into the project domain. One respondent cited the use of sensors including RFID tags that were being used to track material in a mill alongside others that were described as laying all the right foundations to be AI-ready, though right now the operation is lacking enough data for such technologies to be useful, and still relies on experts for decision-making.
- **Barriers to adoption:** several respondents identified certain barriers to adoption including those related to data and integration, responsibility and decision-making, and cultural resistance. Many respondents cited quality of data as being a big barrier to adopting new technologies such as applying machine learning and AI applications. The need for better integration between existing systems and the need to create an open architecture were also cited as challenges. On the topic of responsibility and decision-making, one respondent said that older generations of decision-makers are often the furthest from the technology and the least technology savvy. Many respondents felt that the onus was on engineering and construction companies to tell the owners what was required in terms of technology and make suggestions for innovation.
- **Where the interest lies:** respondents expressed interest in advanced technologies for a broad range of applications including scheduling, project delivery, cost reduction, and training. Many respondents said they were having conversations about certain technologies, but have not often moved beyond this stage.

Conclusion and discussion

Overview

The study's findings confirm its hypothesis and echo similar perspectives from other industry sources: that digital adoption in capital projects in Australia's M&M industry has been limited to date.

The findings also reveal important insights into capital project methodology, performance, digital maturity, and the attitudes, perspectives, and ideas of some of the industry's most experienced leaders when it comes to digital and business innovation.

As some individual successes mentioned by respondents demonstrate, there is measurable value to be gained through digital innovation in M&M capital projects. One respondent said the transition to centralisations they have made over the past six years has driven improvements across all projects. Another respondent described the integration potential of digital as being able to greatly reduce the cycle time of implementing major changes (normally taking weeks or months to process) by 75%. One respondent's global platform for crowdsourcing digital solutions won an industry award and has delivered $10M of free cash flow for some (smaller) companies. Another respondent spoke at length about the value of digital citing an enterprise reporting platform that delivers $10M in improvements each year already. One respondent described a well-established mobile strategy using RFID tags that has driven value for operations in terms of safety and asset management.

While the industry's digital maturity may be young and several common barriers to adoption have been slowing progress, there is significant interest in advancement and a general perception that digital is the way of the future. The questions that arise are how best to get there and which approaches will yield the most valuable path. We address these questions and propose some solutions in the following Impact and Recommendations section.

Key research themes

The following six research themes emerged from the findings. They capture the most significant observations from the study's collection of interviews and form an overarching picture of the current state of digital and business innovation in Australia's M&M industry.

Table 4 – Key research themes

Six key research themes	
1	Digital innovation is still in its infancy
2	Lack of standardisation across the industry
3	Traditional tendencies in project leadership
4	Emphasis on people over technology
5	Positive attitudes towards digital innovation and a desire for better integration and connectedness
6	Three common barriers to digital adoption: structural, cultural, and knowledge

Six key industry insights

These six key industry insights were gathered from a primary research study conducted by Hatch into the challenges and opportunities of digital innovation in the Australian M&M industry.

Digital innovation is still in its infancy

When it comes to the adoption of digital technologies and strategies, the industry is largely still in the discussion phase with marginal trialling or implementation.

Respondents described very minimal to no creation of analytics and predictive metrics or next-level KPIs on projects. None of the respondents had anything that was fully adopted. Most respondents said they had not updated their corporate capital project delivery methodologies to align with new digital tools and applications. Less than half the respondents had workflow-based, well-integrated, and properly codified processes and data requirements. Most respondents described little to no development of digital strategies for capital projects, and most did not have a project-specific digital team (as opposed to support from a central function).

Most reported being in the discussion or early stages of investment in technologies like BIM, digital twins, blockchain, VR, AR, and AI. Most also either had no defined strategy or were thinking of trying out mobility technologies and practices in an ad-hoc or adopt-and-adapt manner without a centralised or consistent approach.

Most businesses are in the discussion or early stages of investment in technologies like BIM, digital twins, blockchain, VR, AR and AI.

Lack of standardisation across the industry

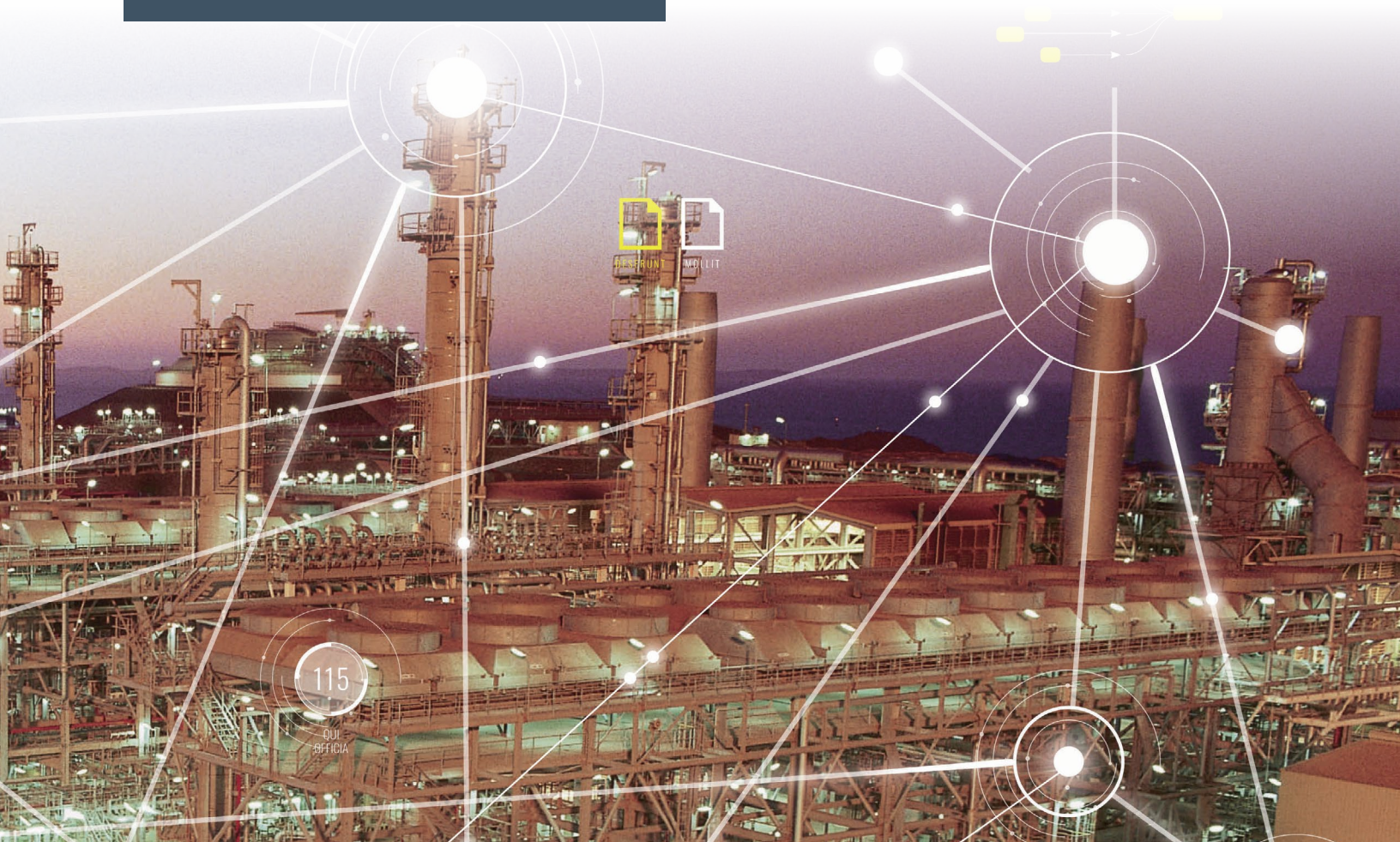
Respondents revealed a lack of standardisation across the industry not only for digital technologies but also for project approaches and methodologies, performance measurement, and benchmarking.

Respondents showed very little commonality on the degree to which projects have historically met budget/schedule targets, and all respondents said they had a varied approach to their project delivery/contracting strategies that depended on project size, type, phase, and many other factors. While larger projects had a centralised delivery function, smaller ones tended to be more regional or commodity-focused.

> ***Most businesses have no single-platform set of project delivery systems that unite the activities of organisations, suppliers, service providers, etc.***

Further, while all respondents used internal and external benchmarks, there does not appear to be a strong industry standard for benchmarking. There is also little standardisation in the use of continuous improvement/delivery excellence programs. KPIs were differentially treated as either a shared or a project-based responsibility.

Not having a single-platform set of project delivery systems that unite the activities of organisations, suppliers, service providers, etc., can cause a massive disconnect. Standardisations in the codification of processes and data requirements is also often overlooked. Furthermore, there is wide variation in the level of adoption and interest in digital technologies.



Traditional tendencies in project leadership

The relative immaturity of digital innovation in the industry may be largely shaped by traditional tendencies in project leadership and project delivery approaches.

Results show that business and project groups tend to be risk-averse and that there is a reticence to change in the industry. Several respondents cited a tendency for project teams to be conservative when it came to delivery models with a common preference to stick to more traditional tried-and-true ones, particularly for major projects and the biggest industry players. One respondent commented, “I do not think we try things just for the sake of trying them,” while another said that project teams are “not incentivised to be creative on projects.”

One respondent described the nature of the process of setting up a project execution strategy as tending to land on a model that is a variation of previous, more traditional ones. Another drew attention to the issue of project decision-makers—because they are often more senior members of the team—being too far removed from new digital technologies, unlike the new generation of project managers that have grown up surrounded by technology.

The nature of the process of setting up a project execution strategy tends to land on a model that is a variation of a previous (more traditional) one.

Emphasis on people over technology

Many respondents emphasised the importance of people over technology when it came to making beneficial transformations.

Most respondents tended to emphasise that the impetus for innovation should be focused on the relationships between teams and partners and how everyone works together rather than on delivery models. To this point, one respondent described the likelihood of success as dependent on how well you manage the model, which comes down to relationships. One respondent described an adopt-and-adapt approach, meaning that projects are driven by team members and enabled by technology.

Particular areas for initiatives that are consistently cited as delivering the greatest improvement in capital project performance and management are people/relationship/cultural initiatives. These include initiatives related to people's well-being, the diversity of teams (i.e., gender diversity, diversity of thought), as well as improving the relationships between people and teams for smoother workflow, and improving the emphasis on better safety and productivity.

One respondent described human factors—turnover rates, work culture, and training adherence—as the most important performance measurement targets on a project. While another cited health, well-being, and engagement as an important part of their corporate improvement program. Another explained that continuous improvement was a concept that was built into the foundational framework of organisations.

Challenges and barriers to digital adoption were often described as being people or relationship barriers. Respondents listed several areas in which relationships could be improved to deliver better value for projects, including earlier engagement with contractors, continuity of working relationships throughout the project life cycle, and generally moving away from delivery siloes towards a more integrated team approach that considers the whole life cycle. One respondent cited the importance of fostering a more collaborative approach to partnerships, information, and gain sharing in the development of more innovative approaches and solutions.

Most businesses leaders agree that the impetus for innovation should be focused on the relationships between teams and partners and how everyone works together.

Positive attitudes toward digital innovation and desire for better integration and connectedness

Overall, respondents had a positive attitude toward digital innovation and saw or understood its potential value across a wide range of areas from operational safety and asset management to productivity. Most were keen or interested in advancing their organisation's efforts. Several respondents expressed interest in advanced technologies like AI, AR, and VR for a broad range of applications including scheduling, project delivery, cost reduction, and training.

One respondent described what they believed would be an inevitable shift from technology being a "thing" to being a tool used by everyone and owned by project team leaders. Another added, "I can only see the requirement for digital growing in the future," while another revealed that "companies that invest now will have the biggest advantage."

"The walls are beginning to come down and there's a change from what has traditionally been a siloed approach… in order to unlock the true value people need to share their information with each other. The intent is there…there's still a journey to go on."

There was generally a desire for better integration and connectedness across organisations and between owners, suppliers, contractors, etc. For those that have not already done so, there is a desire to transition to a more integrated workflow-based system for managing processes and data requirements, with an interest in exploring the potential of a single-platform integrated approach to project delivery systems.

When it came to contracting models, one respondent had a vision for an integrated partnership type model. "The walls are beginning to come down and there is a change from what has traditionally been a siloed approach […] in order to unlock the true value, people need to share their information with each other. The intent is there […] there is still a journey to go on." Another echoed this sentiment, citing the importance of fostering a more collaborative approach to partnerships, information, and gain sharing in the development of more innovative approaches and solutions.

Three common barriers to digital adoption: structural, cultural, and knowledge

Respondents reported a wide range of different challenges and barriers to the adoption of digital technologies, strategies, and innovation that can be grouped into three categories: structural barriers, cultural barriers, and knowledge barriers.

Structural barriers

Structural barriers include insufficient data quality and lack of integration across too many platforms, as well as siloed teams and functions that hamper collaboration and whole –life cycle project approaches.

Several respondents cited the problem of data quality and integrity as being a barrier to adopting more sophisticated analytics. It comes down to getting the data right first. One respondent said some data libraries are not well structured, another described data cleaning as an important part of analysis, and another said that data needed to be in the right format with visualisation tools in place. There is an inherent need for an open data architecture first. Many respondents reported a lack of codification and a lack of an integrated workflow approach to processes and data requirements, many still using a document-centric approach with too many documents. Missing aspects such as variable connectivity in remote locations for using RFID technology, and a lack of uniformity across sites were also given as structural barriers.

One respondent cited a plethora of siloed platforms provided by different suppliers as a challenge for integrating systems properly. Another explained the lack of a standard delivery model meant dealing with constant change which made investment in digital challenging. In a similar vein, a lack of continuity or consistency of resources (i.e., turnover) on a project was cited as a barrier to implementing improvement programs as high-performing resources are not dedicated for five- to ten-plus years.

Cultural barriers

Cultural barriers include traditional tendencies and cultural resistance as well as uncertainty around responsibility for ownership.

Most organisations have people in the business who have done things a certain way for a long time, so there is a big change management component needed in shifting to digital. Older generations of decision-makers are often resistant to or uncomfortable with technology. Another challenge is the reticence of projects or project managers to change once they are up and running.

For example, while you might experience some success with prototypes, the barrier is not about not seeing the value, but rather that the nature of the process of setting up a project execution strategy tends to land on a model that is a variation of a previous, more traditional one.

Many organisations are not using more advanced analytics to tell them something that a person could already tell them. An expert-driven approach is favoured over an analytics-driven one.

Business leaders generally expect that suppliers or partners should bring innovation and there is a corresponding disappointment when it is not found. Such improvement programs are expected to be built into the EPC work plan or innovative approaches taken by the project managers, but most who expect this are not seeing any evidence of it. Another perspective is that the onus is on engineering and construction companies to tell the owners what is required in terms of technology and make suggestions for innovation. You cannot move forward into the digital age if workers on site are still using 2D drawings: there is evident uncertainty around the responsibility for ownership of digital innovation.

Knowledge barriers

Knowledge barriers include an erosion of project delivery expertise, uncertainty around cost versus benefit, and a general lack of knowledge of digital technologies and the possibilities of digital innovation.

One respondent questioned the capability of the industry to correctly understand each contracting model alongside an increasing preference for lump-sum fixed-price contracts which was attributed to a reduced level of experience in the contracting, procurement, and project delivery capabilities across the industry. In other words, an erosion of project delivery expertise.

Another respondent had trialled some innovative initiatives without any beneficial results. One respondent said they had tried implementing more advanced analytics but found they were not getting better insights than their project services people could tell them. More so than demonstrating a lack of value, these responses seem to represent a lack of knowledge about the right ways to go about digital innovation initiatives.

Some respondents still questioned the value of making particular digital updates or going through the trouble of creating complex systems when they could just use contractors' and suppliers' tools. Another respondent echoed this hesitation to over-invest in a fully integrated suite of project delivery tools.

One respondent had concerns over losing intelligence and flexibility to cater to different clients and projects through the process of aggregating data under one platform. Similarly, one respondent said they were sceptical about implementing a capital projects digital strategy because the benefits cannot always be quantified, and another cited the need for demonstrable value before investing in advanced technologies. One respondent also noted that even if the value is present, opportunity can be missed as a result of the value being challenging to quantify. Additionally, several respondents expressed uncertainty about whether what they were doing was innovative or not. Questions such as "is this innovative?" or "what is an innovative model?" arise. A similar lack of understanding was demonstrated in one response admitting a lack of understanding of how BIM was different from digital twins.

A disconnect in the understanding of the scope and capability of digital advances was mentioned by one respondent with contractors and suppliers. People who deliver projects may not necessarily think like operators. The respondent also described a tendency to create static models, not those that learn and change. Another respondent talked about confusion surrounding tools available in the market and the current lack of value being delivered by big platform companies that fail to target solutions appropriately. Another respondent echoed this, citing the challenges of being able to sort through the gimmicks to find the value.

> ***"One of the biggest challenges for some is simply being able to sort through the gimmicks to find the value."***

Study limitations and future research

This study was focused on gaining insight from the Australian M&M industry. As a result, the study's sample size was small and while it is likely that much of the findings could be generalised to other countries and other similar industries, this cannot be guaranteed. Future research should focus on investigating the level of digital adoption, sophistication, and attitudes and perspectives in other countries and industries.

Impact and recommendations

Impact

If Australia's M&M industry is to continue to thrive as the backbone of the country's economy into the future, a shift toward greater digital innovation is the necessary way forward.

While other industries from manufacturing to finance have embraced this shift and seen revolutionary gains in everything from productivity to bottom-line profit, to date the M&M industry has been falling behind the curve. The industry must look to these examples as well as those cases of success by other M&M organisations noted in this study to support the case for change.

This study is significant in that it is one of the most targeted primary research studies conducted to date into the Australian M&M capital projects industry. It has enabled greater insights into the current state of digital innovation as well as a proper understanding of industry- and organisation-specific attitudes, perspectives, and barriers to adoption. The level of detail in many of the ideas shared enables our resulting recommendations to leverage a greater degree of specificity, actionability, and confidence than has previously been possible when deliberating about digital innovation in the M&M industry.

With this knowledge we can determine how best to overcome hurdles and which areas of digital innovation we ought to be focusing on to maximise returns on investment and open up opportunities to reach full potential in both the short- and long-term horizons for organisations and the industry as a whole.

Recommendations

As individuals, as organisations, and as an industry, we all need to understand and to challenge the structural, cultural, and knowledge barriers to digital change that are holding us back. Because the nature of the capital projects industry insulates it from external disruption, we must drive change from within.

There are many examples of brilliant individuals, excellent capital project teams, and innovative solutions in the industry that deliver exceptional results. But individual efforts in isolation cannot change an entire industry. If we want to reach our full potential, we must make these changes not in a piecemeal fashion but together as an industry, as part of a supportive ecosystem on the journey to a digital future.

Those who innovate, those who foster a culture of trust and collaboration, and those who integrate a holistic approach to digital transformation from a project's foundations will drive greater value, profitability, and resilience.

We present nine recommendations which are grouped under three pillars of success: leadership, vision, and Strategy; people and culture; and technology foundations. The recommendations are based on and informed by the study's six key research themes. **Table 5** shows how the pillars of success and the recommendations within each pillar address the key research themes.

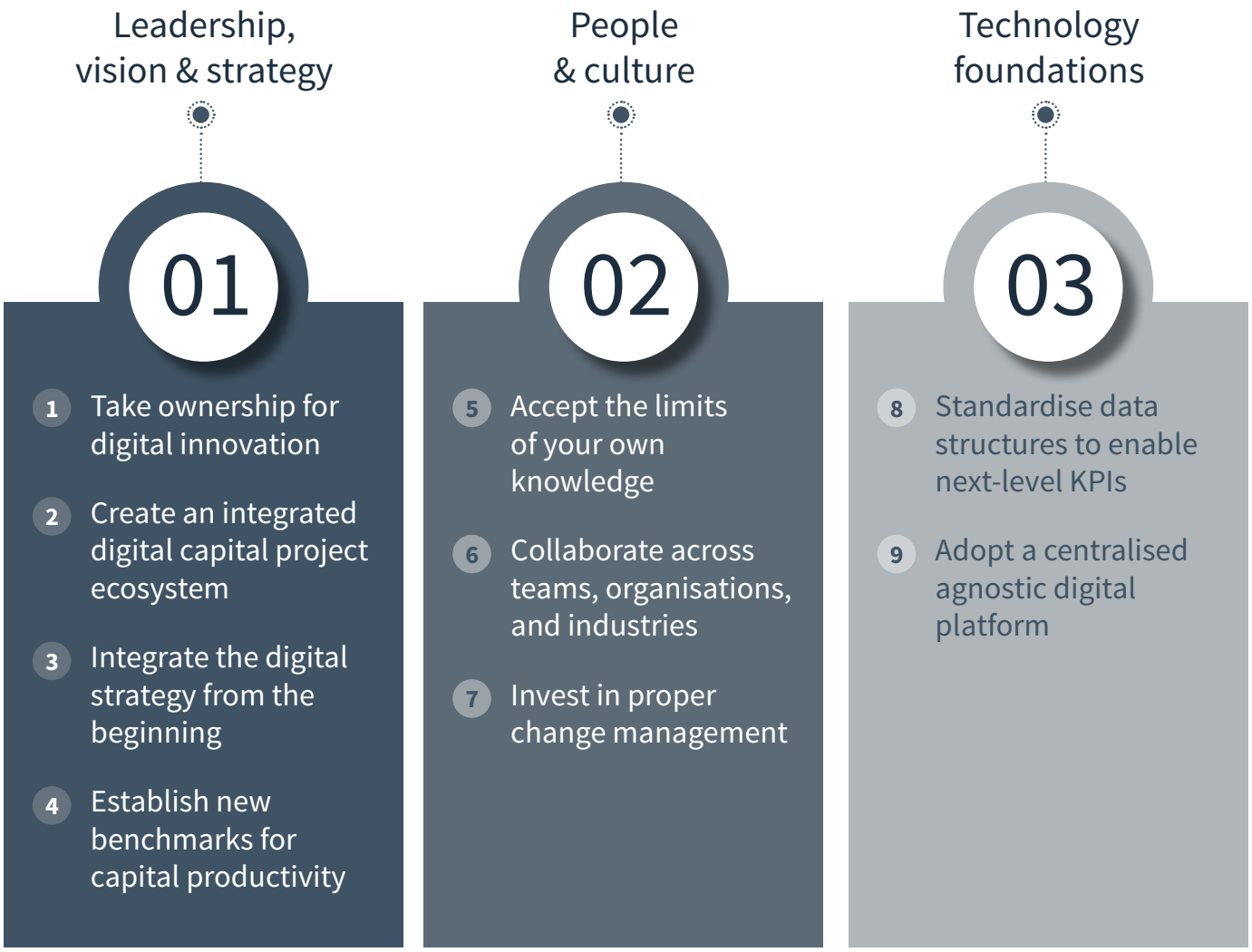
These recommendations are relevant to all stakeholders in the M&M industry—from business leaders and operators, to financiers and digital technology providers. They will also be of interest to those who work in a broad range of commercial-industrial, asset-intensive, engineering, and construction settings around the world.

Table 5 - How the pillars of success and recommendations address the key research themes

Pillars of success	Nine recommendations	Key research themes addressed
Leadership, vision, and strategy	1. Take ownership for digital innovation 2. Create an integrated digital capital project ecosystem 3. Integrate the digital strategy from the beginning 4. Establish new benchmarks for capital productivity	1. Digital innovation is still in its infancy 2. Lack of standardisation across the industry 5. Positive attitudes towards digital innovation and desire for better integration and connectedness 6. Common barriers: cultural, knowledge
People and culture	5. Accept the limits of your own knowledge 6. Collaborate across teams, organisations, and industries 7. Invest in proper change management	1. Digital innovation is still in its infancy 3. Traditional tendencies in project leadership 4. Emphasis on people over technology 5. Positive attitudes towards digital innovation and desire for better integration and connectedness 6. Common barriers: cultural, knowledge
Technology foundations	8. Standardise data structures to enable next-level KPIs 9. Adopt a centralised agnostic digital platform	1. Digital innovation is still in its infancy 2. Lack of standardisation across the industry 5. Positive attitudes towards digital innovation and desire for better integration and connectedness 6. Common barriers: structural, knowledge

Three pillars of success and nine recommendations

The three pillars of success and the nine recommendations that follow are built on the six key industry insights presented in this report.



Recommendation 1

Take ownership for digital innovation

Leadership, vision, and strategy

Any large-scale change requires strong leadership. Yet the study's findings reveal that there is no industry-wide view of who should lead and be responsible for the industry's digital transformation. Owners lamented a lack of digital innovation from engineering and construction suppliers. Suppliers expressed the challenges of innovating given the lack of data quality and lack of standardisations in project requirements, engagement models, and process systems from different clients. Most respondents seemed to believe the onus for digital innovation was on somebody else.

Both owner/operators and suppliers need to take better ownership for digital innovation. The journey to a digital future starts with a leadership commitment from the top that is properly articulated and embraced across all dimensions of the capital project ecosystem.

Owner/operators need to accept responsibility for their role as agents of change and must enforce the mandate for improved productivity and efficiency and greater transparency and collaboration through digital innovation.

Suppliers must accept responsibility for their role as agents of change in delivering more innovative digital solutions while making a more concrete case for the value to be gained.

As digital leaders we must be responsible and take ownership for:

- Creating a digital capital project ecosystem that enables better integration and collaboration.
- Integrating digital strategy right from the earliest stages and aligning it with the organisation's overarching vision.
- Establishing new benchmarks for capital productivity that challenge traditional targets and strive for higher goals.
- Accepting the limits of our own knowledge and committing to better educating ourselves and our organisations about the possibilities of digital innovation.

Good leadership is the cornerstone of success in any domain, and it is equally true of digital innovation in the M&M industry. The time to step up is now, while we still have the ability to take control of our organisations' digital trajectories.

The journey to a digital future starts with a leadership commitment from the top that is properly articulated and embraced across all dimensions of the capital project ecosystem.

Recommendation 2

Create an integrated digital capital project ecosystem

Leadership, vision, and strategy

The study's findings demonstrated on many different fronts—from contracting models and delivery methodologies to data systems and performance measurement—just how heavily fragmented the industry's capital project ecosystem is. The findings also revealed that individual efforts at investment were falling short because of a lack of interconnectedness between parties.

All participants in the capital projects ecosystem should recognise their shared interest in developing greater collaboration, fluidity and transparency across the whole ecosystem.

All participants in the capital projects ecosystem should recognise their shared interest in developing greater collaboration, fluidity, and transparency across the whole ecosystem and its full project life cycles in order to improve capital productivity. Transformative change will require support and input from all industry stakeholders working together.

Ever since the capital projects industry moved toward outsourcing engineering and construction, there has been a persistent unwillingness to share information. To drive improvements in efficiency and achieve a step-change in productivity, participants must change their perspective and process of sharing what has historically been protected as proprietary information, just as the leaders in the manufacturing industry did twenty years ago.

A new, reimagined digital project delivery model must contain a strong and consistent foundation including detailed requirements, business processes, roles, and responsibilities. This model should incorporate revised industry benchmarks and data governance practices that enable the industry to gain better and deeper insights as well as realise benefits across the full asset development life cycle. To reiterate though, the maximum value will only be achieved when the new, reimagined model is shared across the industry to achieve a more standardised approach to capital projects.

A new digital ecosystem should engage and enable innovative thinkers and provide opportunities for projects to embrace a more agile approach where collaborators are rewarded for introducing innovation. Examples of agile approaches that can deliver value in the capital projects industry are the creation of more frequent review points, focusing on outcome rather than deliverables, reducing the level of detailed (restrictive) contractual and workflow-based requirements, and using a single set of project delivery systems.

Establishing the digital ecosystem and providing a clear mandate for change will enable the necessary evolution of the current delivery methodologies. This direction and mandate must come from the owner community and be supported by a commitment that is shared by all stakeholders to innovate the entire ecosystem.

Recommendation 3

Integrate digital strategy from the beginning

Leadership, vision, and strategy

The study demonstrated a clear need for the development of capital project digital strategies. In fact, 72% of respondents had no digital strategy and most identified the development of a more sophisticated one as a future goal of their organisations. Companies that invest now will have the biggest advantage.

For digital strategy to be successful, we need to take a step back and reimagine the approach in the new digital era. A digital strategy must be more than a document that simply ticks a box.

A group-wide capital projects digital strategy should have a triple focus:

1. Facilitating the enhanced delivery of projects
2. Establishing the foundation for digitally advanced projects of the future.
3. Set yourself up for "digital operations."

It starts with understanding that digital is more than technology.

It starts with understanding that digital is more than technology. Software and hardware will continue to change and evolve. A sustainable and transformative digital strategy must take a more holistic view. It must be embedded into an organisation's vision, culture, methodologies, work practices and processes, data governance, systems and tools, and fully embraced by all project participants. A robust digital strategy considers and maps the detailed behavioural and cultural changes that must take place before digital value can be fully realised. The aim should be to establish a culture of project innovation enabled by digital technologies to achieve business goals.

Business leaders need to be clear about the business vision and value to be unlocked on the digital transformation journey and keep that in focus. It is important to frame investment in technologies like BIM and digital twins in the context of an overall digital strategy to ensure the value potential can be properly articulated and measured. The assessment of value must not be artificially constrained to the capital project life cycle; it must extend beyond individual projects into all future capital expenditure and capture potential improvements in operational efficiency and productivity. Doing so can avoid fruitless dabbling in piecemeal experiments that lead to the erroneous belief—and massive missed opportunities— articulated by a couple of respondents that there is insufficient value to be gained in digital innovation.

As with all digital journeys, the path to value will unfold over time. At the start, the exact route may be unclear. It may take several steps or iterations to arrive at frameworks that serve the business' goals. Amplifying the "small wins" can help to create the necessary momentum to drive larger scale change and to form the basis for the development of a culture of digital innovation.

Organisations must take a long-term view and be confident that investment in the early stages of the project will deliver long-term improvements in engineering, construction, speed of start-up, operational productivity and efficiency, and business resilience into the future. Experience shows that it is harder to introduce digital culture into an ongoing project or existing operation than it is to implement earlier in the life cycle.

In our experience, an early investment in digital strategy is the best way to maximises the value gained from its implementation. As one of the study's respondents offered, one of the biggest success factors in meeting project targets was the development of divergent solutions in the early stages. While another said the potential of digital when considered early on was a relatively small investment.

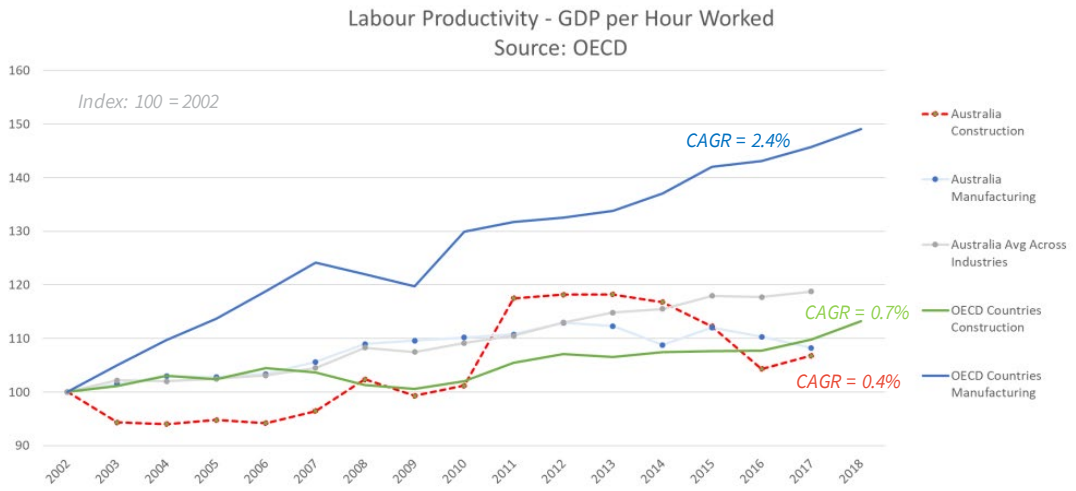
Finally, business leaders must go one step further, providing the sandbox for validating the new digital strategy. Smaller, less critical projects provide the ideal opportunity to experiment, learn quickly, and demonstrate and quantify value.

Recommendation 4

Establish new benchmarks for capital productivity

Leadership, vision, and strategy

When compared to other industries such as manufacturing, the numbers show that the construction industry is lagging in capital productivity. As highlighted in the graph below, both Australian and global productivity in construction have been flat over the past fifteen-plus years: 0.4% and 0.7% compounded annual growth (CAGR) while global manufacturing has improved by 2.4% CAGR over the same period. This may largely be due to the use of outdated and inconsistent benchmarks across the industry that are perpetuating the current level of productivity.



The study revealed that most respondents used their own historical projects as internal benchmarks, yet there was a concern expressed by many over data quality and data governance issues and a lack of standardisations across projects which would make it challenging at best to establish accurate benchmarks by which to measure the performance and success of current projects.

In order to establish new benchmarks for capital productivity, **projects need to start from a solid foundation that involves measuring the right metrics and standardising data structures to enable the development of next-level KPIs.** In presenting a more detailed, relevant, and comparable picture of project performance, these KPIs will enable the development of new benchmarks that drive better capital productivity across the industry.

However, in order to uplift the entire industry, we need to work together. The current fragmentation of the capital project ecosystem means that no one party has all the information to assess estimates and budgets or to accurately determine labour productivity. To truly reset capital productivity expectations, all ecosystem participants must agree to disclose detailed information. Incentives and motivations must be redefined and aligned to achieve higher levels of capital efficiency across the entire project and the entire ecosystem.

Organisations that embrace change, seek innovation, and look to be more collaborative and transparent can establish new benchmarks in capital productivity and deliver significantly higher levels of shareholder returns.

Recommendation 5

Accept the limits of your own knowledge

People and culture

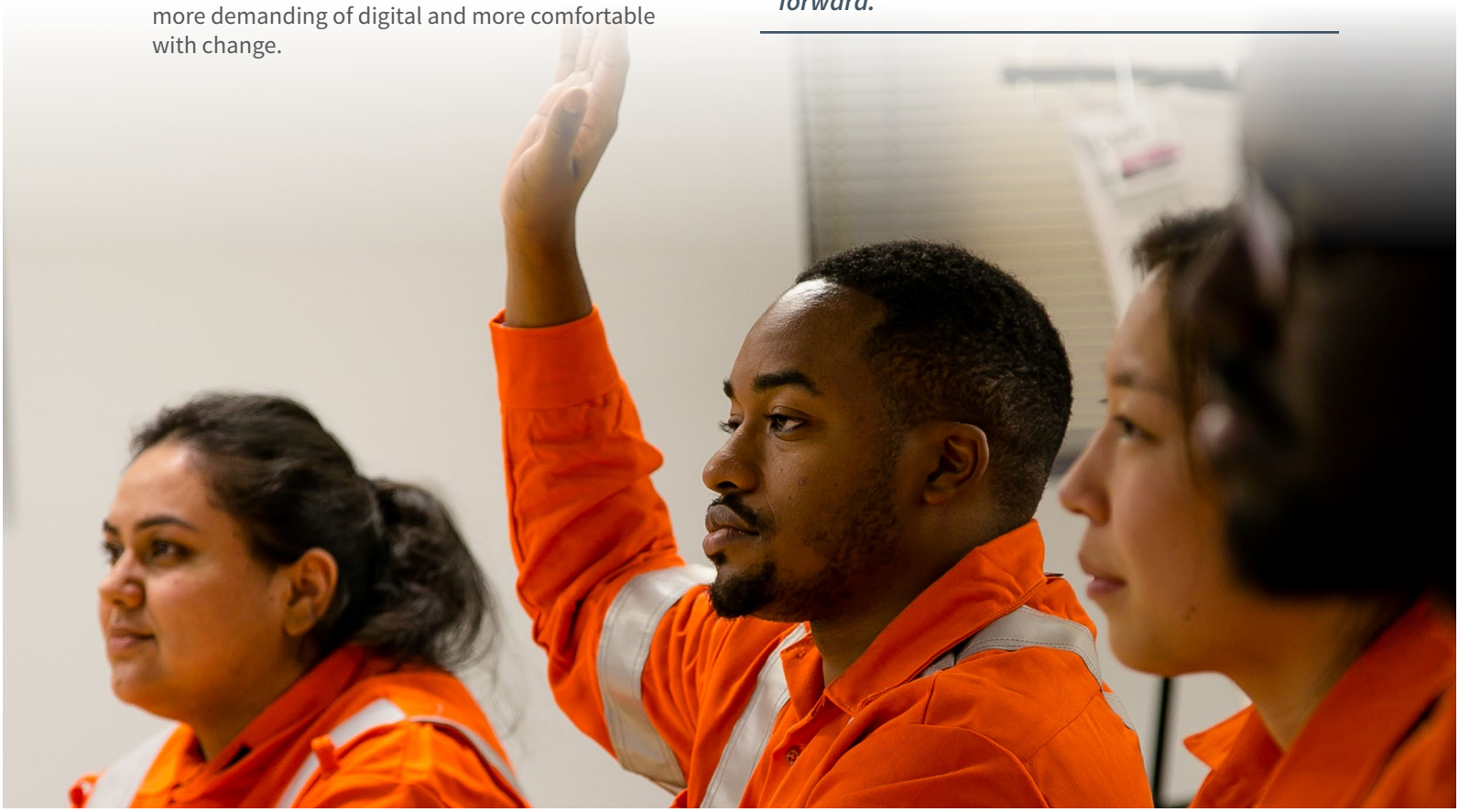
Digital is a complex topic. To make informed choices, key decision-makers must have an understanding that extends beyond high-level presentations and software whitepapers.

The study's findings revealed that many senior project leaders lack sufficient knowledge and expertise to make informed decisions about digital technologies and to properly understand their potential applications and the kind of value they can deliver. Furthermore, they reported not having the time to investigate every new digital trend and thus were reliant on support from their internal digital teams and external suppliers.

At the same time, the industry is experiencing a generational change. Soon the majority of project and construction managers will come from a generation that have grown up with digital technologies glued to the palms of their hands. These individuals are becoming more demanding of digital and more comfortable with change.

Senior project leaders must recognise and accept the limits of their own knowledge when it comes to digital innovation and work to better educate themselves by leveraging the expertise of more junior team members who have a closer understanding of the potential applications and value of digital. Project leaders must also support and enable those members who may be better equipped to drive innovation forward. Project leaders should therefore look to gather input on digital decision-making from the entire team and even the whole ecosystem as early as possible in the project life cycle.

Project leaders must accept that across their team there is a real desire to reimagine capital projects and support and enable those members who may be better equipped to drive innovation forward.



Recommendation 6

Collaborate across teams, organisations, and industries

People and culture

A culture and a mandate for collaboration must underscore every part of the path forward for M&M organisations and industry stakeholders to unlock the value of digital innovation.

Several respondents in the study spoke of the benefits of taking a more integrated team approach that considers the whole project life cycle. This meant earlier engagement with contractors and continuity of working relationships (a big concern for many respondents) throughout the life cycle to reduce the delivery siloes when it came to how people worked together. One respondent cited the importance of fostering a more collaborative approach to partnerships, information, and gain sharing in the development of more innovative approaches and solutions.

Business and project leaders must take responsibility for setting a direction and tone for change that prioritises collaborative approaches and modes of working, and demand full transparency and visibility into all aspects of the ecosystem. They must create a digital capital project ecosystem that enables better collaboration, and they must be willing to share detailed information across teams, organisations, and the industry overall. The barriers are beginning to come down and organisations are starting to come around to the idea that there is more value in sharing information than protecting it, but the industry still has plenty of room to transform itself into a more collaborative ecosystem.

Some respondents even offered specific suggestions for building a more collaborative ecosystem such as alternative delivery models (i.e., integrated owner's team or alliance frameworks) and having engineering and construction teams working together in the design environment.

In order to collaborate effectively, project leaders must be willing to accept the limits of their own digital knowledge and seek input from their whole project team, enabling those better equipped to drive innovation. They must also invest in proper change management to shape a collaborative culture and help individuals understand and in turn champion the benefits of collaboration.

The importance of fostering a more collaborative approach to partnerships, information and gain sharing in the development of more innovative approaches and solutions can't be overstated.

Recommendation 7

Invest in proper change management

People and culture

In asset-intensive industries it is easy to forget that humans—not machines—are the engine of our success. Our most valuable assets are people, because without them nothing can run.

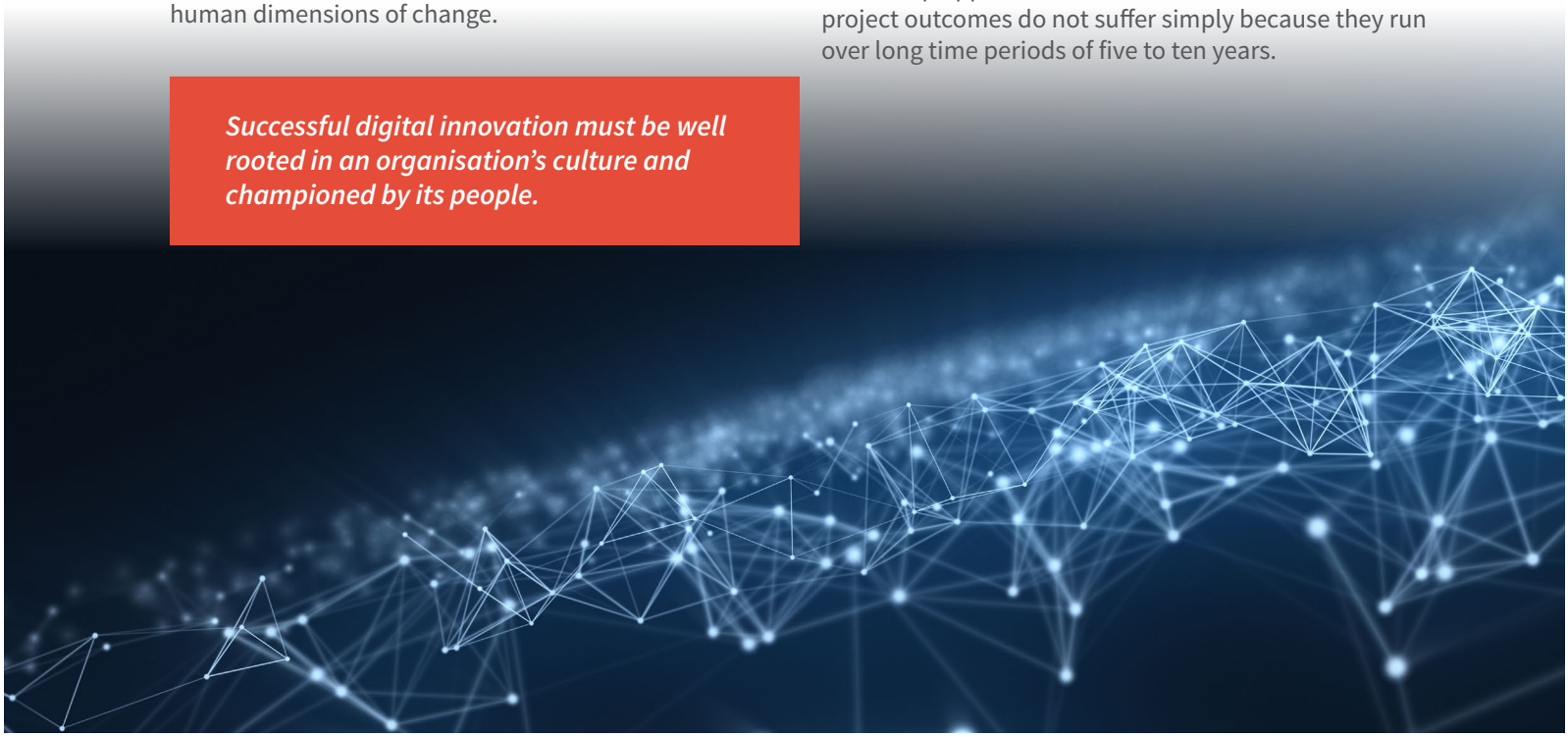
It should come then as no surprise that most of the study's respondents emphasise that the impetus for innovation should be focused on the relationships between teams, partners, and how people work together. To bolster this point, the type of initiatives study respondents most frequently cited as delivering the greatest improvement in capital project performance and management were people/relationship/cultural initiatives. These included initiatives for people's well-being, the diversity of teams, improving relationships for smoother workflow, and emphasizing the importance of better safety and productivity.

Accordingly, successful digital innovation must be well rooted in an organisation's culture and championed by its people. The path to achieving this solid foundation is through proper change management—a fundamental field for all forms of innovation that focuses on the human dimensions of change.

Successful digital innovation must be well rooted in an organisation's culture and championed by its people.

The capital projects industry has a strong and well-established culture. Intense schedule pressures, long hours, and travel to multiple distant locations has established strong beliefs and practices amongst experienced industry professionals. Many respondents described ingrained traditional and conservative approaches to projects where leadership tends to be risk-averse and there is a general reticence to change in the industry. Thus, an earnest investment in a well-structured change management plan is crucial to transforming organisational culture, beginning with leadership attitudes and extending throughout. In addition to a shift in leadership attitudes, central digital teams and project groups must do more to incentivises the receiving parties to be more accepting of digital deliverables and digital ways of working.

Change management can help address the concerns of lack of continuity of human capital throughout the life cycle of a project by digging deep into the human impacts of change, team relationships, and handover practices. Such initiatives can determine what leadership approaches need to be taken to ensure project outcomes do not suffer simply because they run over long time periods of five to ten years.



Recommendation 8

Standardise data structures to enable next-level KPIs

Technology foundations

Building a strong digital foundation is a completely necessary precursor to the successful adoption of more advanced digital tools and technologies. This begins with standardising data structures to enable next-level KPIs so that data can yield smarter insights that drive significant improvements not just for the duration of the project but across the entire life cycle of the asset.

One of the main barriers to digital adoption revealed in the study was a lack of data quality, a crippling bottleneck for digital innovation. Several of the study's respondents cited unwieldy documentation and data structures that were not well integrated with each other and were document- rather than workflow-based. Vast amounts of data, some useful and some not, are being collected from different systems and processes in siloed software applications.

Additionally, project structures and systems are being managed inconsistently from one project to the next, making data contextual only to the project it came from and comparison between projects difficult or impossible. Furthermore, data systems between the different parties (between owners and suppliers, and from one client to the next) frequently differ and don't speak well to each other. Compounding this are the arbitrary restrictions in specifying deliverable formats and systems which is creating additional manual effort, manual rework, data loss, and a degradation of intelligence.

Taken together, all of these weak points create an environment of poor data quality which limits the sophistication of data analysis for performance improvement within a project, limits the formation of useful benchmarking between projects for organisation-wide performance improvement, and limits the scope for developing next-level KPIs and applying digital innovation to move the needle industry-wide on productivity and efficiency. Indeed, a majority of the study's respondents (78%) confirmed they were still using traditional KPIs, lagging indicators derived from only a sub-set of the data available on a project.

Projects must put in place detailed definitions for exactly what data is required and how it will be used, as well as how systems need to be configured to ensure the right data is available in the right format and how the proper handover will be managed so that data is not lost or degraded as it moves through the various systems. If data governance is currently document-based it should be re-structured as a workflow-based system to ensure functionality and outcome are guiding the process. Projects must invest in data mapping, creating common data structures that map data exchanges between systems and establish a construct to integrate data into a common environment. Data mapping will allow further development of next-level KPIs that use advanced analysis to identify trends and correlations in real time to forecast project disruptions and reveal previously invisible opportunities for performance improvement.

Manual collection and reporting of data is labour-intensive, time-consuming, and expensive, and often happens infrequently, resulting in delays in access to information for project leaders. Data collection and reporting should be automated as much as possible to save time, money, and increase real-time access to information.

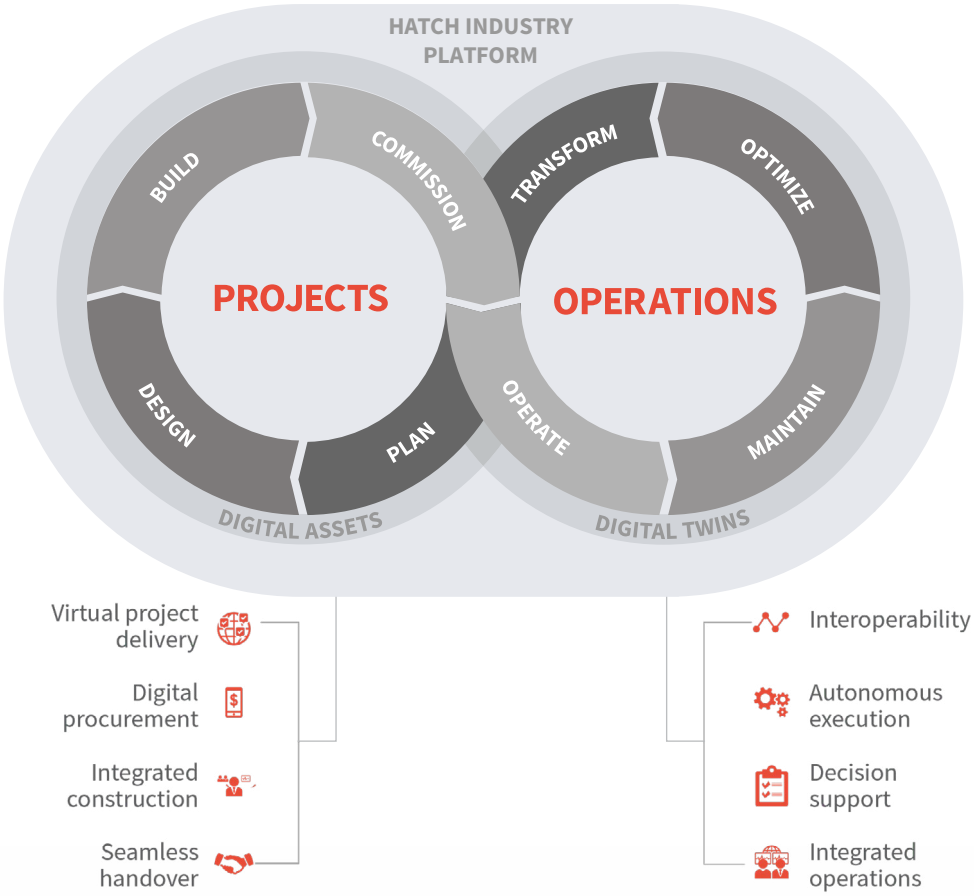
The value of building a strong digital foundation also extends to early implementation of digital technologies and data-centric techniques such as engineering design automation, robotic fabrication, 4D construction sequencing, and RFID material tracking, which can reduce people hours in engineering, procurement and construction, shorten the project schedule, and achieve an improved project NPV. Such a digital foundation also has the potential to deliver significant benefits to subsequent parts of the value chain, from improved operations readiness and faster ramp-up, to ongoing operations and maintenance performance improvement and optimisation. But these technologies need to integrate with well-designed data systems across the value chain in order to achieve their full potential. In turn, these technologies can form the foundation for more advanced ones such as AI applications.

The establishment of clear data structures is the tipping point for realising the full potential of digital innovation. It is the proverbial walking that needs to be mastered before we can run.

Recommendation 9

Adopt a centralised agnostic digital platform

Technology foundations



One of the study's respondents expressed concern over the lack of provision by any one technology vendor of a platform that offered a complete package of tools to deliver a project. Others echoed the inadequacy of current market solutions when it came to digital tools that could properly dig into the complexities of capital projects and disentangle the relevant threads to deliver real value. There are too many digital add-on gimmicks that dilute the potential of digital innovation by failing to deliver results.

M&M business leaders, consultants, and technology providers should be collaborating on the development of a centralised platform that serves the needs and unites the systems of all stakeholders throughout the life cycle of a capital project and beyond into the operational phase. Such a platform should serve as a mechanism by which projects can be used in a positive feedback loop, serving as springboards for future projects and enabling the continual evolution of digital innovation in capital projects.

Once data can be structured to arrive from different systems in a clean and clear format that can be intelligently integrated with data from other systems to derive next-level KPIs, the platform in which it can be brought to life needs to be centralised, agnostic, and accessible to all project stakeholders. It needs to serve the full range of design and delivery requirements of a project from inception to completion and beyond. A single centralised platform can also serve as an industry-wide standardisations tool for everything from KPIs and benchmarks to project contracting and delivery approaches.

With a scalable architecture, a centralised platform can be developed and refined on smaller, less critical projects first to provide a proof-of-concept whose success can be measured in order to demonstrate such a platform's usefulness for larger projects. A scalable platform can then be of use across an organisation's full portfolio of projects of all sizes.

Adopting a centralised platform should be the ultimate aim of an organisation's efforts to improve data quality, standardise data structures, and develop next-level KPIs and benchmarks. With emphasis on strong leadership and integrated digital strategy, open and enthusiastic collaboration and change management efforts, it is a well-defined and worthwhile goal for organisations looking for the right digital path forward.

A centralised platform is the digital foundation from which organisations will have the ability to grow and scale their digital investments to reap unprecedented value today and well into the future.

Such a platform is a critical pillar of sustainable and resilient business operations, and those who act quickly stand to gain a significant competitive advantage that will establish long-term positive returns.

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Useful links

From digitisations to transformation — unlock long-term, sustainable value

Digital Mining: It's a brave new world — The journey to unlocking value in mining

Digital twin: a disruptive tool to meet today's challenges

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Whatever our clients envision, our engineers can design and build. With over six decades of business and technical experience in the mining, energy, and infrastructure sectors, we know your business and understand that your challenges are changing rapidly.

We respond quickly with solutions that are smarter, more efficient, and innovative. We draw upon our 9,000 staff with experience in over 150 countries to challenge the status quo and create positive change for our clients, our employees, and the communities we serve.

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