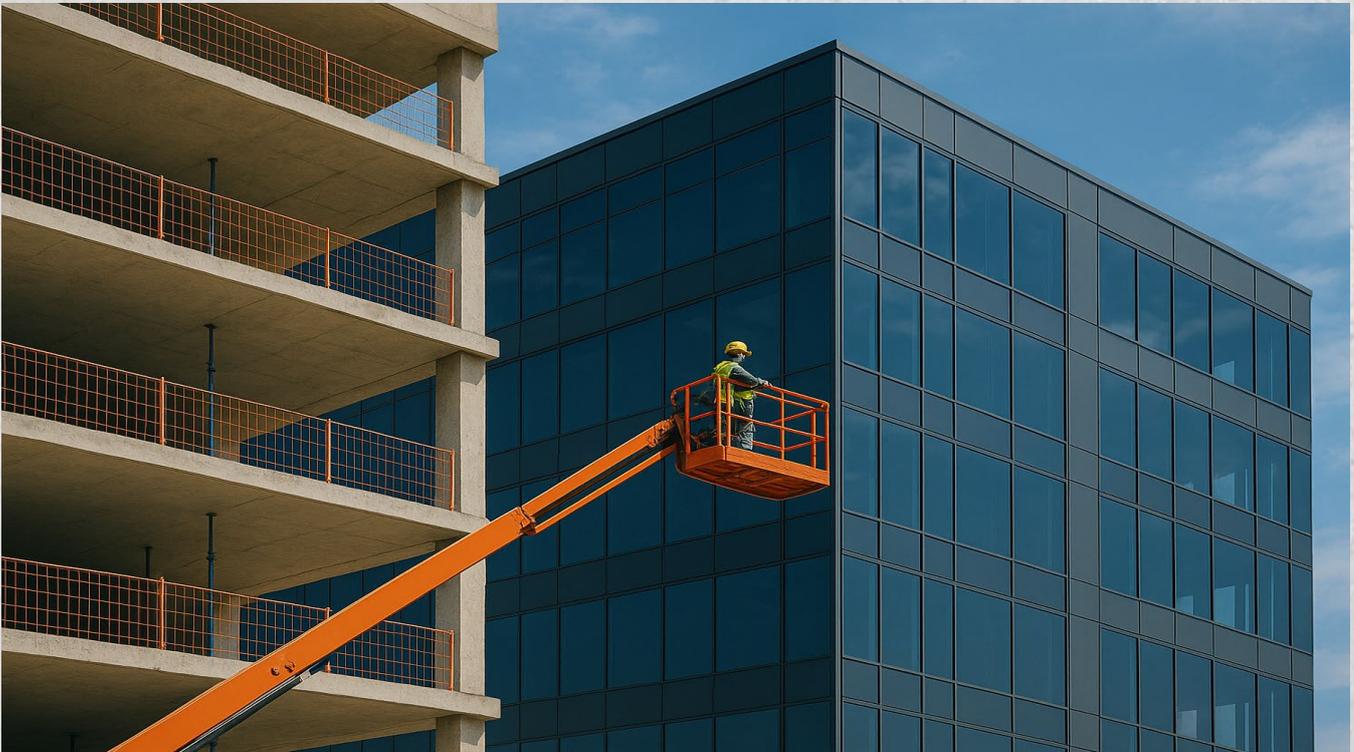


building
4.0 crc

PROJECT #56: ACCELERATING B4.0CRC TRANSLATION AND IMPACT

FINAL REPORT



Australian Government
Department of Industry,
Science and Resources

Cooperative Research
Centres Program

ACKNOWLEDGMENTS

ACKNOWLEDGEMENT OF COUNTRY

We acknowledge the people of the Kulin Nations, on whose land - Narm/Melbourne - we have undertaken this project and conducted most project activities. Narm is on the traditional lands of the Kulin Nation. The Kulin Nation is a collective of five Aboriginal clans: Wurundjeri, Boonwurrung, Wathaurrung, Taungurung and Dja dja wurrung. We acknowledge the Traditional Custodians of the Wurundjeri Woi Wurrung and Bunurong Country where the University of Melbourne and Building 4.0 CRC offices are based at.

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Disclaimer: Diligent efforts have been made to acknowledge the original owners of the materials used in this report, and a list of references and bibliography are attached towards the end of this report. Wherever external figures, graphs, and images have been produced in the report, we have cited the original sources.

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ABBREVIATIONS

ACBEE	Accelerating Change in Built Environment Education
ARC	Australian Research Council
AWS	Amazon Web Services
B4.0CRC	Building 4.0 CRC
BIM	Building Information Modelling
BPC	Building and Plumbing Commission
CAHS	Canadian Academy of Health Sciences
CEM	Construction Engineering and Management
CII	Construction Industry Institute
CKE	Construction Knowledge Exchange
CMR	Construction Management Research
CPD	Continuing Professional Development
CRC	Cooperative Research Centre
ECR	Early Career Researcher
GDP	Gross Domestic Product
HDR	Higher Degree by Research
IAO	Innovation-Adopting Organisation
IGO	Innovation-Generating Organisation
IoT	Internet of Things
IP	Intellectual Property
LMS	Learning Management System
MBAV	Master Builders Australia Victoria
PhD	Doctor of Philosophy
R&D	Research and Development
SDG	Sustainable Development Goal
SME	Small and Medium Enterprise
SPSS	Statistical Product and Service Solutions
STA	Science and Technology Australia

#56 Accelerating B4.0CRC Translation and Impact

CONFIDENTIAL:

Yes No

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Disclaimer

The Building 4.0 CRC has endeavoured to ensure that all information in this publication is correct. It makes no warranty with regard to the accuracy of the information provided and will not be liable if the information is inaccurate, incomplete or out of date nor will we be liable for any direct or indirect damage arising from its use. The contents of this publication should not be used as a substitute for seeking independent professional advice

1. EXECUTIVE SUMMARY

Globally, the building sector is one of the largest sectors of today's economy, representing approx. 13% of GDP and employing 7% of the world's working age population. In Australia, the building industry is the fifth largest contributor to the economy and contributes around 10% to the GDP,^{1,2} employs around 1.4 million Australians, and looks after collective investments of 14.8 million Australians in the real estate sector. Thus, it is essential that the building industry benefits from the latest research and new knowledge created through rigorous research programs.

One such platform that promotes industry led research initiatives is the Building 4.0 CRC (B4.0CRC), which is co-funded by the Australian Government and industry partners. This CRC aims to produce industry engaged research that enhances internationally competitive, dynamic and thriving Australian advanced manufacturing sector, delivering better buildings at lower cost and the human capacity to lead the future industry. Thus, it is critical for us to explore the factors that can hinder or reduce impact of collaborations between industry and research partners within the CRC ecosystem.

This project investigates the gaps that impact researchers and building industry leaders during collaborations for producing novel research and practical outcomes for enhancing impact. We conducted a multi-method exploratory research study using a grounded theory approach with systematic literature reviews, focus group discussions, in-depth interviews with industry leaders and researchers engaged in Building 4.0 CRC projects, and gathered participant insights and case studies that were gathered and developed during Cruxes Innovation's two professional development programs and training activities, namely Base and Trek programs. We investigated how industry specific factors, institutional factors, academic factors, skills, behaviours, and experiences influence industry leaders and researchers while they engage with each other to conduct engaged research (co-create research) and produce practical knowledge that solves industry challenges. The key findings from these research tasks are summarised in the Section 5 and summarised briefly below.

Factors that support collaborations between researchers and industry partners for creating impact:

1. Effective Communication
 - Having a "translator" or champion communicator in industry organisations
 - Clear communication of expectations and goals upfront
 - Using visual aids and accessible formats for sharing findings
2. Alignment of Goals and Expectations
 - Setting clear plans for research continuity
 - Ensuring projects address real-world problems relevant to industry
3. Ecosystem Involvement
 - Engaging broader industry experts to ensure wider applicability
 - Facilitating conferences and gatherings for networking and brainstorming
4. Practical Demonstrations
 - Encouraging proof of concepts and prototypes
 - Showcasing research potential through real examples
5. Training and Skill Development
 - Upskilling researchers on translating research for practical impact
 - Creating "super teams" with experience in both academia and industry
6. Open Innovation Approach
 - Viewing standards and regulations as potential enablers
 - Encouraging innovation trials to boost evidence and confidence

¹ Source: <https://www.trade.gov/country-commercial-guides/australia-building-construction> (Date of Access: 03 March 2025).

² Source: https://treasury.gov.au/sites/default/files/2020-09/115786_PROPERTY_COUNCIL_OF_AUSTRALIA_-_SUBMISSION_2.pdf (Date of Access: 03 March 2025).

Factors that hinder and derail the collaborations between researchers and industry partners, leading to diminished impact:

1. Misaligned Objectives
 - Different "North Stars" for academics (peer recognition) and industry (client/stakeholder satisfaction)
 - Disconnect between academic research goals and industry priorities
2. Communication Challenges
 - Multiple levels of decision making removing technical experts from discussions
 - Lack of technical professionals equipped to communicate across diverse stakeholders
3. Risk-Averse Culture
 - Tendency to comply with existing practices rather than innovate
 - Reluctance to be the test case or to be the first to do trial for new methods or products
4. Lack of Support Structures
 - Insufficient bridging individuals, organisations or consultants with industry experience
 - Absence of structured joint research projects
5. Skills and Knowledge Gaps
 - Misalignment in understanding of research methods between academia and industry
 - Digital maturity gaps across different company sizes
6. Resource Constraints
 - Time pressures and high-performance expectations in academia
 - Difficulty in securing industry support (funding, data access) for research projects.

Based on the findings above, we make the several recommendations regarding how industry-academic collaborations can be supported within appropriate collaboration policy, regulatory, and governance frameworks, that ensure benefits are realised, research and practical impact being produced, and risks are mitigated. Particularly, we recommend using research impact frameworks and tools to frame or draft potential and actual research impact outcomes that can boost industry and practical outcome. We propose an example framework which can be revised further for such engaged projects in CRC and other similar institutional settings. We also recommend creating impact indicators that can allow both sides to track, monitor, and measure academic and practical impact in short-term, medium-term, and long-term. We offer some examples and case studies for such impact frameworks and indicators in Chapter 6. This will allow the future engagement leaders to craft/design their own impact frameworks and indicators using the past best practices and well-established ways of assessing impact over time.

2. PROJECT OVERVIEW AND OBJECTIVES

Australian building sector is not only one of the largest economic sectors of the country, it is also the leading sector for shaping the present and future of Australian infrastructure, cities, and physical assets. To excel, the building industry requires co-creation, drawing, and collaborating with Australian research and technology ecosystem to thrive alongside the global building industry as well as to lead the cutting-edge advancements in the world. Research translation and collaboration for practical impact are critical for the success of such collaborations between research and industry stakeholders.

A variety of factors can hinder such collaborations, translations, and co-creation of research for advancing the collective practical knowledge. One such factor is the capability gap for researchers and industry professionals involved in such programs, which further increase the difficulties of adopting and translating research into industry impact and industry outcomes as well as starting engaged research projects for practical impact.

This research project aims to investigate key drivers and hindrances that impact research–industry collaborations. We undertook research to investigate this question using multiple sources of evidence. As part of this research project, two professional development programs were also developed and delivered for B4.0CRC researchers and industry partners to explore how development of capabilities and skills for research translation and impact for researchers and industry leaders can impact research–industry collaborations and their outcomes.

The empirical findings and evidence from this project support the CRC’s vision of developing a thriving Australian advanced manufacturing sector by enabling industry to direct and draw on Australian research through a scalable methodology that upskills researchers and industry professionals in collaboration, engagement, and adoption of innovations.

3. BACKGROUND AND CONTEXT

3.1. The Role of the Building and Construction Industry in Australia

The building and construction industry is a cornerstone of the Australian economy, contributing significantly to its growth and development. In 2022-23, the industry reported a total income of approximately AUD 568 billion, with Construction services and Building construction sectors contributing AUD 248 billion and AUD 217 billion respectively.³ This sector accounts for around 10% of Australia's Gross Domestic Product (GDP), underscoring its pivotal role in the nation's economic landscape.⁴

3.2. The Academic Contribution to Building and Construction

Australia's academic landscape is both expansive and deeply integrated into the building and construction industry. The nation boasts 43 universities, comprising 37 public and 6 private institutions.⁵ A significant number of these universities offer dedicated programs and maintain research centres focused on the building and construction sector. For instance, RMIT University provides specialised courses in building and construction management, underscoring its commitment to advancing industry knowledge.⁶

Beyond individual programs, several universities have established research centres that collaborate closely with industry partners. The University of Melbourne's Faculty of Architecture, Building and Planning, which includes the Melbourne School of Design, is a notable example, actively engaging in research that addresses contemporary challenges in the built environment.⁷ Similarly, the University of Wollongong's SMART Infrastructure Facility serves as a multidisciplinary research institution, focusing on innovative solutions for infrastructure development and management.⁸

Financially, the Australian government demonstrates robust support for research in this domain. In 2024, the Australian Research Council (ARC) allocated over \$64 million to support research partnerships, including \$29.8 million for six new Industrial Transformation Training Centres and \$34.7 million for seven Industrial Transformation Research Hubs.^{9,10,11} While these figures encompass various sectors, they highlight the substantial investment in research collaborations that often benefit the building and construction industry.

Moreover, the Building 4.0 Cooperative Research Centre (CRC) exemplifies the synergy between academia and industry. This initiative, co-funded by the Australian Government, received a \$28 million grant, capitalising on a combined \$103 million from industry, government, and research partners, culminating in a total research budget of \$131 million over seven years.¹² This CRC aims to revolutionise the building industry through technological advancements and innovative practices.

³ Source: <https://www.abs.gov.au/articles/tradies-continue-lead-way-568b-construction-industry> (Date of Access: 15 March 2025).

⁴ Source: <https://www.trade.gov/country-commercial-guides/australia-building-construction> (Date of Access: 15 March 2025).

⁵ Source: <https://www.studyaustralia.gov.au/en/plan-your-studies/list-of-australian-universities> (Date of Access: 15 March 2025).

⁶ Source: <https://www.rmit.edu.au/study-with-us/building> (Date of Access: 15 March 2025).

⁷ Source: <https://research.unimelb.edu.au/study/options/areas/architecture-building-and-planning> (Date of Access: 15 March 2025).

⁸ Source: https://en.wikipedia.org/wiki/SMART_Infrastructure_Facility (Date of Access: 15 March 2025).

⁹ Source: <https://www.arc.gov.au/news-publications/media/media-releases/more-64-million-funding-support-research-partnerships> (Date of Access: 15 March 2025).

¹⁰ Source: <https://sites.research.unimelb.edu.au/research-funding/mi> (Date of Access: 15 March 2025).

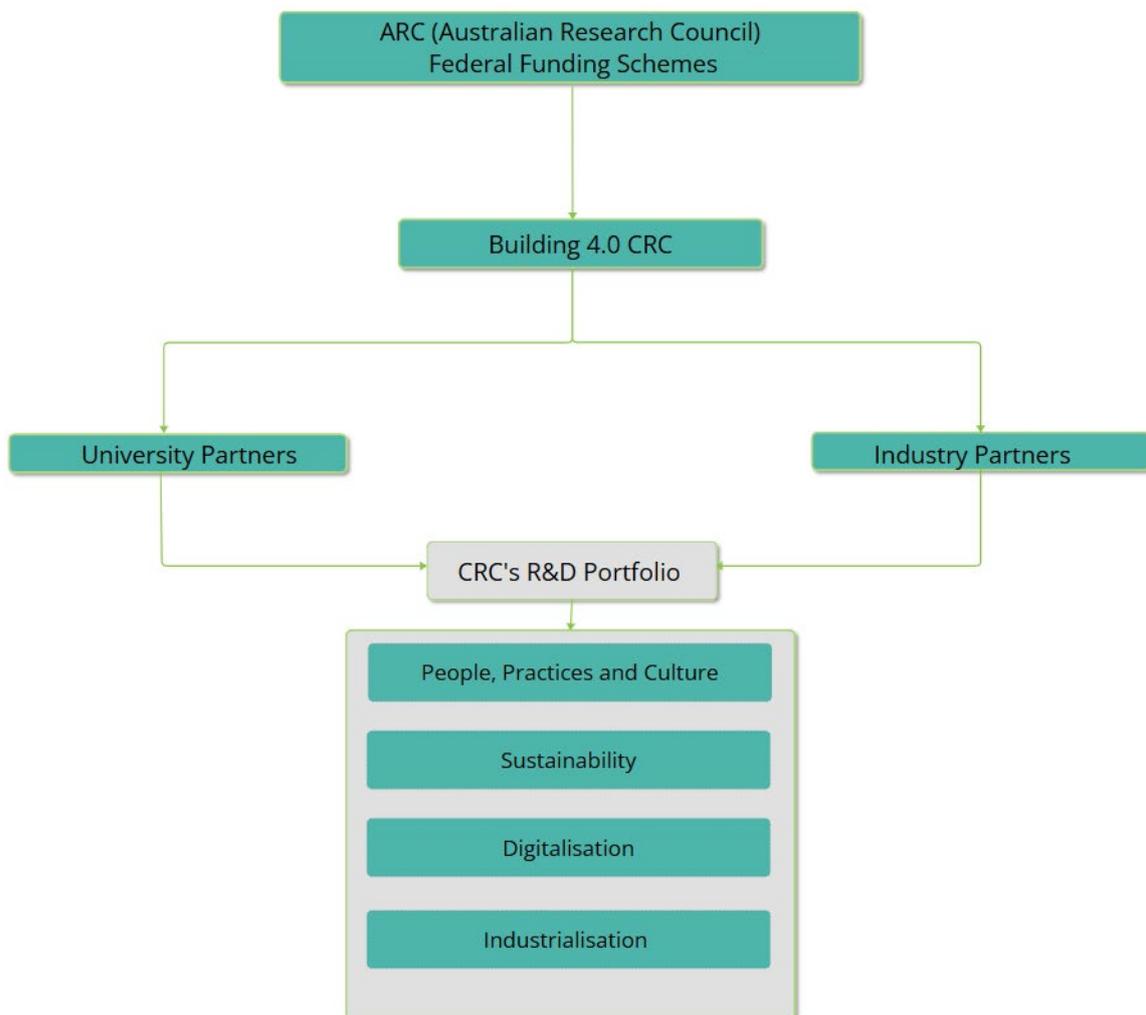
¹¹ Source: https://en.wikipedia.org/wiki/ARC_Training_Centre_for_Automated_Manufacture_of_Advanced_Composites (Date of Access: 15 March 2025).

¹² Source: <https://www.monash.edu/mada/news/2020/28-million-grant-building-4.0-crc> (Date of Access: 15 March 2025).

3.3. What is the Building 4.0 CRC?

The Building 4.0 Cooperative Research Centre plays a transformative role in Australia's construction industry. Launched in 2020, this industry-led research initiative aims to address longstanding challenges such as stagnating productivity and limited digitisation.¹³ By fostering collaboration among industry leaders, academic researchers, and government bodies, the Building 4.0 CRC seeks to use digital solutions and innovative processes to create a more efficient, sustainable, and customer-centric construction sector. This initiative not only enhances building practices but also contributes to economic growth by positioning Australia at the forefront of construction innovation.

Figure 1. Building 4.0 CRC structure



¹³ Source: <https://www.vba.vic.gov.au/about/research/building-4.0-crc-digital-transformation-of-the-building-industry> (Date of Access: 15 March 2025).

3.4. Goals and Scope of Building 4.0 CRC

The CRC's scope encompasses a wide range of initiatives aimed at transforming the building industry, including:

- Developing new industry-wide cultures, practices, and standard protocols to enable sector-wide transformation
- Promoting more sustainable design and construction practices
- Innovating the building processes and techniques by using the latest technologies, data science, and AI
- Improving building hardware and processes to enhance all key phases, including development, design, production, assembly, operation, maintenance, and end-of-life.

3.5. Main Objectives of Building 4.0 CRC:

The CRC is committed to addressing systemic challenges in the construction industry, including stagnant productivity, high waste, and low-profit margins. Its primary objectives are:

	Enhancing Efficiency	<ul style="list-style-type: none">• Implementing advanced manufacturing and digital technologies to streamline construction processes, aiming for a 30% reduction in project costs through digital technology and off-site manufacturing.
	Promoting Sustainability	<ul style="list-style-type: none">• Developing environmentally friendly building practices to achieve up to a 50% reduction in CO₂ emissions for more sustainable buildings.
	Improving Quality and Safety	<ul style="list-style-type: none">• Enhancing building quality and safety standards to reduce defects and increase customer satisfaction.
	Fostering Collaboration	<ul style="list-style-type: none">• Bringing together industry leaders, academic researchers, and government bodies to create a cohesive ecosystem that drives innovation and addresses industry challenges collectively.
	Advancing Skills Development	<ul style="list-style-type: none">• Providing training and education programs to equip the current and future workforce with the necessary skills to adapt to new technologies and methodologies in construction, including training 36 PhDs and 1,000 master's Students.

Through these efforts, the CRC aims to position Australia at the forefront of global advancements in the construction industry, ensuring it is well-equipped to meet future demands and challenges.

3.6. How Does Building 4.0 CRC Work?

The CRC collaboration operates as a dynamic and structured ecosystem, bringing together industry leaders, academic researchers, government agencies, and technology providers to drive cutting-edge research and development in the construction sector.

Given the large-scale and multi-stakeholder nature of the CRC, smooth collaboration is essential to ensure that research innovations translate effectively into industry applications. The teams work in an interdisciplinary and cross-sectoral approach, where industry partners provide real-world challenges, and commercial insights, while academic institutions contribute rigorous research methodologies, technological expertise, and innovation frameworks.

Regular progress meetings, knowledge-sharing sessions, and milestone updates are conducted to ensure that projects remain on track, as well as aligned with both academic advancements and industry demands. Since R&D takes time, maintaining well-synchronised collaboration between partners is critical to maximising impact, ensuring that research is not just theoretically sound but also commercially viable and scalable.

The CRC's structured approach ensures that funding is utilised efficiently, avoiding duplication of efforts while accelerating the translation of research into tangible industry solutions. Given that the Building 4.0 CRC is a long-term initiative with high expectations for technological advancements, fostering strong communication, shared goals, and continuous engagement among all partners is vital to unlocking its full potential and driving lasting transformation in the Australian construction industry.

3.7. Partnerships: Who is Involved?

Building 4.0 CRC collaborates with a diverse and extensive network of partners across multiple sectors, aiming to drive innovation and transformation in the construction industry. Among its government agency partners, the Building and Plumbing Commission (BPC) (formerly the Victorian Building Authority) and the Department of Jobs, Precincts and Regions (Victorian Government) play a crucial role in regulatory alignment and policy support.

The CRC engages with over 50 partners spanning government, industry, education, and technology. It fosters a dynamic and interdisciplinary ecosystem, accelerating the adoption of digital transformation, automation, and sustainability in the Australian construction industry. The partnerships are classified as follows:

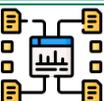
- Industry Associations: Master Builders Association Victoria (MBAV), Green Building Council of Australia, PrefabAUS, Standards Australia.
- Vocational Education Institutions: Holmesglen Institute.
- Industry and Commercial Partners: Includes leading companies in construction, technology, and manufacturing such as Lendlease, Bluescope Steel, Sumitomo Forestry, Schiavello Construction, Donovan Group, and Amazon Web Services (AWS).

A comprehensive list of Building 4.0 CRC partners can be found on the official [Building 4.0 CRC website](#).

4. METHODOLOGY

4.1. Overview

The research project involved a multi-method approach, using a variety of datasets and inputs, to study the enablers and hindrances for research–industry collaborations.

Summary of Methodological Approaches	
	1. Focus Group Discussions/Workshops
	2. and 3. Analysis of Literatures (research as well as practice)
	4. Surveys
	5. In-depth exploratory qualitative research (through interviews)
	6. Training Program Datasets and Case Studies

4.2. Research Activity 1 – Focus group discussions

As the first formal event of this project to launch the research components of this project, discussion forums were organised on 5th December 2023 at the Building 4.0 CRC Headquarters in Caulfield and on 6 December 2023 via Zoom. Representatives from academic institutions and industry partners associated with several B4.0 CRC projects were invited to participate in the discussion forum and focus group discussions.

These facilitated discussion forums were organised in hybrid mode (face to face, as well as Zoom option) to allow for more participation across various partner organisations based in various Australian regions. The forums were hosted plus facilitated by the project team. A list of questions was shared in advance with all participants via the invitation email and calendar invitation to provide them with context and an overview regarding the topics that will be discussed during this forum. We asked all participants to prepare for the forum by taking a few moments to reflect on these questions and we encouraged them to note down any specific experiences/instances that they would like to share with us on the day.

List of discussion forum questions that were shared with the participants:

- **What barriers have you observed or experienced when working towards research translation goals?**
- **What barriers have you observed or experienced in adopting research-based innovations into your practice?**
- **What enablers or enabling factors have you observed or experienced that work well to support effective translation and adoption of research-based innovation into your practice?**

This two-hour discussion forum was divided into two segments. The first session focused on introductions, group formation, and group discussions in the allotted group areas. We assigned participants to groups in such a way that there was a mix of industry representatives and researchers in each group. All groups were given 15 minutes to discuss the barriers and 15 more mins to discuss the enablers. The second session of the discussion forum focused on asking the group members to report their group discussions with the entire forum and then facilitated open discussions among all participants were held. Overall, across the two days of discussion forums, 31 individuals participated and contributed to the forums.

Outputs from this discussion forum and focus group discussions contributed towards recommendations for understanding the collaboration landscape within B4.0 CRC, understanding how to cultivate research translation, and understanding the effectiveness and scalability of professional development programs as a methodology to develop engagement and collaboration leadership capabilities. This forum also informed the training priorities and areas of focus for the professional development programs organised by Cruxes Innovation.

At the end of the discussion forum, we provided an outline of the planned professional development programs that were made available for B4.0CRC researchers and industry partners as a part of this project.

Appendix 2 contains the focus group discussion/workshop invitation that was used for recruitment of participants.

4.3. Research Activity 2 – Academic Literature review of scientific and peer-reviewed journal articles

For conducting the scientific literature review, the process involved selecting high quality journals based on their relevance to the research area and their Scopus Q1 rating (which is an indicator of journal quality in its field or research discipline). Journals with a high impact factor were prioritised to ensure inclusion of high-quality, peer-reviewed articles. The selection process focused on topics that address themes, such as the building and construction industry's collaboration with academia, technological innovations with research partnerships. The search for relevant articles was conducted by using advanced search options available on Google Scholar. Such advanced options allowed for a more focused and precise search, filtering the search results by journal, keywords, and specific time frames or year of publication. By narrowing the search using these options, the database provided articles specifically aligned with the research themes. In addition to Google Scholar, we conducted extensive literature search through other databases to ensure comprehensive coverage of academic and scientific journals plus publication sources, such as, ResearchGate, ScienceDirect database, and Sage database. These databases provided access to peer-reviewed journal articles, conference proceedings, and other types of academic literature, such as book chapters and edited textbooks. Using multiple databases ensured the inclusion of diverse perspectives and research published in different parts of the world.

The literature search was conducted between 25th June 2024 and 31st July 2024 to review articles published within the last two decades. We paid particular attention to current trends and developments. The search strategy was iterative, which means that the keywords and search parameters were adjusted throughout the process to capture the most relevant articles.

In addition to the focused search on high quality Q1 journals, a more general search was performed to discover additional relevant papers which might not have appeared or been published in top quality journals but were very relevant to our topic. During this phase, we came across a number of articles published in journals classified under Q2 rating of Scopus were found. Although these journals were ranked slightly lower than the Q1 journals, the articles contained significant contributions relevant to the project's research theme. These Q2 journals were carefully screened, and only articles that met the core criteria of academic rigor, scientific quality, peer-review, and topic relevance were included. The final list of journals that were included in this search is given in Table 1 in Appendix 1.

The following keywords were utilised throughout the literature search process. These keywords were interchanged and recombined for each search iteration to capture a comprehensive range of relevant articles:

- "Construction Industry" + "Gap in research and practice"
- "Construction Industry" + "Academia and Industry Collaboration"
- "Building Industry" + "Academia"
- "Construction Engineering" + "University and industry collaboration"
- "Construction industry" + "Academic Research"
- "Construction Industry" + "Collaboration with Academia"
- "Academic and Industry Research Collaboration" + "Construction Industry"
- "Construction Management" + "Academic Research and Industry Collaboration"
- "Construction Industry" + "Research Collaborations" + "Building Industry"
- "Research and Development" + "Construction Industry"

Each key-phrase search was adjusted by interchanging the above listed keywords to explore different angles of the research topic, ensuring that no relevant article got missed in the search results or got overlooked during the review. This comprehensive approach allowed the inclusion of a wide variety of literature from diverse range of disciplines, ranging from theoretical studies to empirical research on academia-industry collaboration and innovation within the building industry. Every article retrieved from our search was logged meticulously with its DOI, publication source, and summary of its key findings. This systematic documentation allowed for easy cross-referencing and ensured that all literature was then ready to be reviewed and could directly contribute to our research's findings and resulting overarching themes. The project lead then reviewed the literature to omit any articles which might not have been relevant to the topic. The final list of articles included in this review is given in the Table 3 in Appendix 1.

Finally, a qualitative analysis was conducted to produce the first order and second order themes from this literature review. The key summary and findings from this literature review are reported in the Section 5.2.

From a methodological perspective, we find a predominance of mixed-method research approaches, integrating quantitative and qualitative data to explore diverse facets of the construction industry. Furthermore, in this section, we provide a methodological review, i.e. we review the details of key methodological approaches deployed by these academic research studies, along with sample sizes, data types, and methodological trends we found in the research published about building and construction industry, from a variety of disciplines, including engineering, management and other related fields.

Multiple research methodologies were found to be deployed across the articles, including semi-structured interviews, surveys, case studies, focus groups, workshops, and bibliographic analyses. This highlights the diversity and complexity of studying the construction industry, emphasising collaborative efforts, the need for multidisciplinary knowledge, and the adoption of both traditional and innovative research techniques. Many articles deployed mixed research approaches, which highlights that the dynamics of construction engineering and management often require multifaceted tools to capture the industry's interrelated aspects. Overall, the articles represented a global perspective, with research being conducted from the United States, the United Kingdom, Australia, Malaysia, Europe, to emerging parts of the world, and other regions, signalling a clear focus to study the building industry.

In terms of methodological approaches, we find the following patterns in the academic literature review:

	<p>Surveys</p>	<p>Most frequently deployed approach to gather information from industry practitioners and academics. Often designed to identify critical skills (e.g. BIM competencies), perceptions on industry trends (e.g. attitudes toward Industry 4.0), and to measure success factors and barriers to innovation.</p>
	<p>Case Studies</p>	<p>Several studies adopted a case study methodology approach to delve deeper into specific cases of academia-industry collaborations, project management, and applications of innovative technologies, providing in-depth analyses of outcomes with high internal validity but limited external validity.</p>
	<p>Focus Groups and Workshops</p>	<p>These methods were adopted to facilitate structured discussions among stakeholders, promoting the exchange of ideas, information, knowledge, and to facilitate production of collective insights as well as shared patterns of experiences.</p>
	<p>Interviews</p>	<p>Semi-structured interviews were also used in some studies to understand detailed and situational aspects of projects and concepts. Interviews often were found to supplement the quantitative data collected from surveys and case studies.</p>
	<p>Action-Research</p>	<p>Limited research articles utilised an action research approach, where cyclic processes are deployed to tackle real-world problems through close collaboration between researchers and practitioners where both are trying to analyse and solve the problem in parallel.</p>
	<p>Bibliometric and Content Analysis</p>	<p>Limited research used bibliometric analyses, such as bibliographic coupling and keyword co-occurrence, to map academic patterns, trends, and to draw inferences regarding thematic correlations.</p>
	<p>Modelling Techniques</p>	<p>Modelling approaches such as framework development (e.g. MOCHA) and process modelling (e.g. IDEF0) were applied to represent complex interactions and inform framework evaluations in some of the articles.</p>

Sample Sizes and Types of Data:

- Sample sizes varied considerably across studies, ranging from small-scale surveys and workshops to extensive surveys with hundreds of responses. For instance, the survey of construction owner organisations included 550 participants. On the other hand, an evaluation of BIM education incorporated input from 85 construction professionals.
- Types of data gathered included both subjective data, such as individual perceptions (e.g. views on innovation) and objective metrics (e.g. performance indicators). There is a wide variety of data across the studies, including interview transcripts, archival documentation (e.g. emails, contracts, meeting records), survey responses, educational curricula, and publication records.

Units of Analyses:

- Individual and cross-case analyses are present in the literature, acknowledging the utility of comparing different individuals and case studies to derive broader insights about the phenomenon.
- Limited studies focus on organisations as the unit of analyses, perhaps due to the limited access to multiple organisations to study the problem.
- Almost no studies focus on comparing ecosystems or country wide sectors to compare how the national systems, policies, and regulations influence the building industry.
- Ethical considerations and researcher safety emerge as significant concerns, especially in more immersive approaches like ethnography, where accountability and adherence to ethical standards are critically scrutinised.

4.4. Research Activity 3 – Literature review of agency/industry reports

This literature review focused on gathering and reviewing industry reports, white papers and other technical statements from the last six years related to industry-academia collaboration within the construction sector, specifically within Australia across all states/regions. Various sources were accessed for finding relevant articles, including university websites, government portals and industry association websites. The literature review targeted practical insights from real-world projects, that reveal how industry and practice led projects and partners report on the collaborations. These reports provide us with a more applied perspective as compared with the literature review of academic articles and research studies published in journals.

Key platforms included:

- **University Websites:** These were reviewed extensively, especially focusing on Australian universities such as the University of Melbourne and others known for their collaboration with the construction industry.
- **Government Portals:** A variety of websites and portals, including but not limited to Infrastructure Australia, the Australian Parliament House, Building Commission and other state-level government sites, were accessed for searching official reports on collaborative construction projects.
- **Industry Associations:** Reports from industry associations, such as the Major Projects Association, were reviewed to search for any insights regarding industry practices and partnerships with academia.

The literature search was conducted initially in March 2024 and then this literature search was refreshed over a two-week period between 12 August and 26 August 2024 to allow for inclusion of all latest reports on the topic. This time frame allowed for a focused investigation of available reports, ensuring that the most recent and relevant documents were included in the review. In terms of timelines of the literature we wanted to capture in this literature review, we used filters for the search results to be from the published year from 2016 and onward. This allowed us to capture relevant reports a few years from before and after Covid19 pandemic. It also ensured we did not capture older and perhaps outdated articles that might be reporting on collaboration models which are no longer relevant to current challenges of the industry-academic collaborations in building industry.

The literature search method involved using Google and Google Scholar, specifically entering queries related to each of Australia's states (e.g. New South Wales, Victoria, Queensland) to gather region-specific reports on industry-academia collaboration in the construction sector. This approach ensured comprehensive coverage across the country, capturing a wide range of state-led and region-specific collaborative initiatives.

The literature search was conducted using regionally focused keywords, such as (not limited to):

- Industry-University Collaboration in Construction + New South Wales
- Construction Innovation Partnerships + Victoria

- Government Funded Construction Projects + University Collaboration + Queensland
- Collaborative Infrastructure Projects + Academia + Western Australia
- White Papers on Construction Industry Partnerships + South Australia.

By using each state in Australia among search keywords, the strategy captured region-specific reports on industry-academia collaboration in construction. The search keywords were varied and adjusted to ensure comprehensive results from all regions. Each retrieved report was recorded with essential details, including the **title**, **author(s)**, **publication source**, and brief summary of its **main ideas**.

Comparative search with other international agencies:

In addition to reviewing regional and Australian articles, we also conducted a focused comparative search, by including sources from the UK and the US, to identify and analyse relevant articles and reports from international institutions and organisations on this topic.

After careful reviews, several articles were removed from the literature that did not fit our topic, and we proceeded to retain only selected articles that are now shortlisted in this literature review. The final list of reviewed articles and reports is given in the Appendix 1 which contains full details of the final shortlisted articles, including their sources (agencies, government departments, industry sources, and industry associations that authored or produced the article/report), geographical region/focus, title of the report, along with a short summary of the report/article.

We analysed this literature using qualitative techniques and textual mining approach and produce the summary of results and key findings from this literature review in Table 4 in Appendix 1.

4.5. Research Activity 4 – Surveys

This project's originally proposed research methodological approach was to conduct multi-waves of surveys for data collection to capture individual quantitative responses from industry and research organisations involved in collaborative CRC projects. This multi-wave longitudinal data collection is a robust approach to collect quantitative data that allows for minimising cross-sectional data biases, and biases common in self-reported data (given temporal gaps limit recall of questions from previous waves of surveys). This approach was chosen specifically to allow us to explore temporal shifts and change in behaviours, especially in terms of patterns of changes from both within individuals and between individual's perspective to explore shifts in communication, translation of research, and other related themes.

Two weeks prior to the launch of professional development program BASE, we launched the pre-program survey among participants. The full questionnaire is available in the Appendix 3. However, the number of participants were 28 participants, which is a very small sample size limiting our ability to conduct any extensive statistical analyses and modelling. Overall, we received only 14 survey responses despite multiple reminders, out of which 4 responses were incomplete. The post-program survey saw a significant drop in responses, with only 5 responses received, out of which 2 were incomplete. Despite the low number of responses received here, we provide a summary of the pre-survey responses in the Section 5.4. We chose not to report the results from post-program survey here since low responses could mean that the participants become identifiable.

Due to this small sample size, we pivoted our methodological approach and moved towards conducting in-depth exploratory qualitative study and case studies as well as used the data and feedback captures from the professional development programs to explore our topic. We provide details of these methods in the following sections.

4.6. Research Activity 5 - In-Depth Exploratory Qualitative study (in-depth interviews)

The in-depth exploratory qualitative study involved 24 structured interviews, including 8 industry leaders and 16 academic researchers, to explore the challenges and enablers of research translation in Australia's advanced manufacturing sector. They were invited through the invitation given in Appendix 4.

The industry practitioners were drawn from leading B4.0 CRC partner organisations, including 1 from A.G. Coombs Pty Ltd, 2 from Master Builders Association Victoria, 3 from the Victorian Building Authority (now the Building and Plumbing Commission), 1 from Sumitomo Forestry Australia Pty Ltd, and 1 from BlueScope Steel (AIS) Pty Ltd, offering valuable perspectives on industry-academic collaboration and real-world application of research outcomes. Complementing this, the academic participants comprised 6 researchers from Monash University, 7 from the University of Melbourne, 1 from Queensland University of Technology, 1 from the University of New South Wales, and 1 from Holmesglen Institute, bringing a wealth of expertise in applied research and industry partnerships. These participants were carefully selected for their prior involvement in Building 4.0 CRC projects and extensive experience in industry-research partnerships, ensuring the interviews captured relevant and informed viewpoints.

To streamline participation and facilitate candid discussions, all interviews were conducted online via Zoom, allowing for ease of scheduling, recording, and analysis, particularly as many industry partners were unavailable for in-person interviews. The structured interview protocol, shared in advance (Appendix 5), revolved around key discussion points, including barriers to effective industry-academic collaboration, strategies for improving research translation, and the overall impact of CRC initiatives on Australia's construction and manufacturing sectors. Each participant was invited via email, where they were warmly introduced to the project and encouraged to contribute their experiences in a 30-60-minute session. The interviews were transcribed, anonymised, and analysed, ensuring confidentiality and integrity in data handling.

Questions for Industry Practitioners

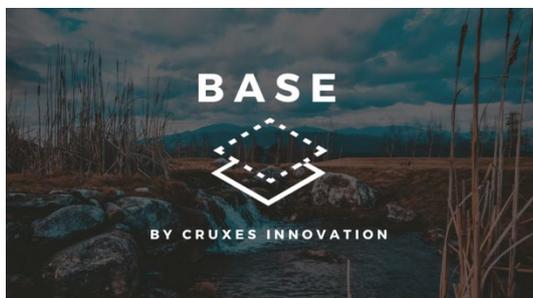
Section	Questions
Section 1 (Barriers & Hindrances)	<ol style="list-style-type: none">1. How do time constraints affect the balance between the industry's need for quick solutions and the time-consuming nature of research?2. What challenges in credibility and project structure hinder innovation and risk management?3. How does misalignment between research goals and funding, coupled with poor communication and data sharing, limit research impact?4. How do complex regulatory environments and the presence of many stakeholders slow down research adoption and complicate policy-related initiatives?
Section 2 (Enablers)	<ol style="list-style-type: none">1. How do targeted KPIs and showing examples encourage innovation and the practical implementation of research?2. In what ways do prototyping and genuine collaboration bridge cultural gaps and foster a conducive project environment?3. How does early stakeholder alignment and advocacy for research in the industry facilitate smoother project scalability and collaboration?4. How does leveraging experienced individuals to translate research into industry applications overcome scepticism and showcase impact?

Questions for Researchers

Section	Questions
Section 1 (Barriers & Hindrances)	<ol style="list-style-type: none">1. How does a gap between research findings and their practical application prevent effective adoption and real-world impact?2. How do time constraints affect the balance between the industry's need for quick solutions and the time-consuming nature of research?3. What challenges in credibility and project structure hinder innovation and risk management?4. How does misalignment between research goals and funding, coupled with poor communication and data sharing, limit research impact?5. How do complex regulatory environments and the presence of many stakeholders slow down research adoption and complicate policy-related initiatives?
Section 2 (Enablers)	<ol style="list-style-type: none">1. How do targeted KPIs and showing examples encourage innovation and the practical implementation of research?2. In what ways do prototyping and genuine collaboration bridge cultural gaps and foster a conducive project environment?3. How does early stakeholder alignment and advocacy for research in the industry facilitate smoother project scalability and collaboration?4. How does leveraging experienced individuals to translate research into industry applications overcome scepticism and showcase impact?

4.7. Research Activity 6 – Data and Feedback gathered from Training Programs by Cruxes Innovation: Base Program and Trek Program

Base Program



- Delivery: Online
- Target: Early career researchers and students
- Building 4.0 Participants: 19

The Base Program ran from 13 March to 17 April 2024. This cohort included 19 participants from Building 4.0, most of whom were PhD or Master's students.

The goal of the Base Program is to introduce research students and early career researchers to the research-impact framework, help them identify a broader perspective on stakeholders or

beneficiaries of their research, and assist them in communicating the value of their research to audiences outside of their research discipline.

At the conclusion of the program, training provider Cruxes Innovation collected feedback from participants. Five out of 19 agreed to provide feedback through an online survey.

Key results from quantitative feedback:

- This program had a 92% satisfaction rating and +80 Net Promoter Score (scored between -100 and +100).
- 80% of the responders felt more confident in initiating conversations with stakeholders.
- 100% of responders felt more confident in communicating the value of their research to those outside their field.
- 80% of responders felt more confident in developing credibility with industry stakeholders.
- 60% of the responders felt more confident in obtaining the support and resources to progress their research towards impact.

Key results from qualitative feedback:

- Participants found the "face-to-face discussions" (that is the one-on-one coaching conversation with the program facilitator) valuable, as well as the opportunity for "listening to other students' research" projects and impact pathways (peer-supported learning).
- Participants benefited from developing a short concise way to introduce their research, and clarifying who are the stakeholders that are integral for research translation and adoption."
- Participants suggested this training could be improved by adding "more time for face-to-face discussion."
- Participants recommended enhancing the program by inviting external industry partners, specifically "invite more people, CEOs and those who have been involved in startups" and "more people from industry or those who have established a successful startup in the construction and building sector."

Trek Program



- Delivery: Online
- Target: Researchers and industry project leaders
- Building 4.0 Participants: 19

The Trek Program for Building 4.0CRC ran between 10 April and 5 June 2024 was a multi-week coaching program designed to equip researchers and industry project leaders with a repeatable methodology to validate the pathways to adoption for research. The Trek Program consisted of four 2.5-hour cohort-based online workshops, an online final 'showcase event' where participants delivered a 3-min 'Research Impact presentation' on their research translation project and key learnings and at least two online 1:1 coaching session per participant.

A total of 11 participants, 3 researchers and 8 industry project leaders completed the program.

The program end evaluation survey was completed by 7 participants.

Key results from quantitative feedback:

- This program had a 100% satisfaction rating and a +43 Net Promoter Score (scored between -100 and +100).
- 100% of respondents believed the program had a significant impact on accelerating their projects towards real-world outcomes. 86% felt that the program placed their projects on a clearer pathway for engaging with industry.
- 57% of participants felt that the facilitators challenged them to step outside their comfort zones, while 86% agreed that the facilitators provided strong support throughout the program.
- 100% of respondents indicated they felt more confident and better equipped to continue conducting stakeholder conversations. The same percentage felt they were now in a stronger position to engage with industry for research collaborations.

Key results from qualitative feedback:

- Participants highlighted several key aspects of the program that added value. In particular, the frameworks and strategies provided for thinking through impact pathways and identifying key stakeholders and their roles in enabling or inhibiting research translation and innovation adoption were particularly valued.
- The final presentation, where participants delivered a 3-minute research impact presentation, provided a platform for participants to gain practice in communicating the value of research-driven innovations while receiving constructive feedback from peers and mentors on ways to address potential barriers of adoption and factors that might fuel or inhibit uptake and wider implementation.
- One key reflection shared by participants was the importance of embedding impact planning and research translation monitoring across the whole cycle of project planning and delivery through the CRC. This ensures that all stakeholders involved in collaborative research projects can have a shared language and expectations on the translation and adoption pathways for research projects from the beginning.

5. DATA ANALYSES, FINDINGS, AND OUTCOMES

5.1 Findings and outcomes of the focus group discussions (Research Activity 1)

We received valuable inputs from participants at the discussion forum and focus group discussions, which we summarise in this section.

Question 1: What barriers have you observed or experienced when working towards research translation goals? What barriers have you observed or experienced in adopting research-based innovations into your practice?

Key barriers highlighted by all groups:

 <p>Problem identification</p>	<p>Ensuring that the problems researchers are working on are what the industry and organisations need to focus on.</p> <p>Focus must be on a real-world problem that resonates with organisations of today need.</p>
 <p>Communication</p>	<p>a. Multiple levels of decision making in such projects where decision makers are often 2-3 steps removed from technical details and are not technical experts remains a big hurdle for such collaborations.</p> <p>b. Industry often has technical professionals that work with researchers in such collaborative projects, but they are not equipped to communicate to multiple players in organisations and universities who are not technical experts.</p>
 <p>Goal Setting</p>	<p>a. Expectation that the management of goals will not be a big issue.</p> <p>b. Objectives of research and their misalignment of industry/organisational drivers and priorities, and vice versa for goals of industry participants misaligned with research goals.</p>
 <p>Risk-averse culture on both sides of the collaboration</p>	<p>Some participants commented that the culture within the industry and academia in Australia is still not to 'innovate or die', but to largely comply with existing practices and standards, and to mitigate risks.</p>
 <p>Lack of a policy framework and industry-driven schemes to seek new solutions</p>	<p>In the US, the industry has a model - private companies are more proactive in developing consulting projects relevant to the needs of the industry where they collaborate actively with universities and research organisations.</p> <p>Those touchpoints and collaborative mechanisms are missing in Australian ecosystem.</p>
 <p>Lack of bridging organisations or consultants (that have worked in the industry)</p>	<p>This hinders or limits the ability to communicate and translate the findings into practical solutions.</p>

Question 2: What enablers or enabling factors have you observed or experienced that work well to support effective translation and adoption of research-based innovation into your practice?

Key enablers highlighted by all groups:



Proof of concepts must be encouraged and widely discussed

Prototypes or demonstrations or real examples can showcase research potential in practical terms



Having the ecosystem's involvement/inputs (not just a specific company or an agency representative)

- a. Utilise tech/industry experts to broaden the scope and ensure wider applicability
- b. Helps the industry as it might be more ambitious
- c. Promote longer term thinking in industry
- d. Setting up clear plans for research continuity while doing such collaborations.



Having a translator – a champion communicator in the industry organisations

- a. Having a communicator in industry and graphic designing capacity within the research team can enable smoother communication
- b. Communicating expectations and goals should be done upfront
- c. Project briefs and proposals must include applied research outcomes, embedded in the project/process to add value to industry and practice
- d. Facilitate conferences and gatherings to create platforms for industry and research leaders to communicate, discuss, and brainstorm applied projects and outcomes



Training individuals that focus on upskilling researchers on how to convey research for practical impact

Training prior to briefing stage and then as the research progresses, so that by the time the final reports and outcomes come through, the translation of the research into practice is a natural next step for the project leads.



Open Innovation is an enabler

- a. Standards and regulations can be enablers, not necessarily barriers, if designed appropriately
- b. Innovation trials to boost initial evidence and confidence among involved stakeholders
- c. Incentives for innovation trialling and adoption are key for those industry partners that have resource constraints and small funding margins (e.g. SMEs, startups, among others)
- d. Universities and research organisations must view research in different shapes and forms; they should be flexible to move across broad range of objectives and constraints to produce practice outcomes and impact.

Key sectoral differences between industry and research ecosystems and associated challenges that were highlighted:

1. Different North Stars!

For academics, the North Star is often the other researchers and journals that evaluate the quality, novelty, and contribution of their research outputs. For industry and business leaders, the North Star could be their users/clients (businesses or individuals), internal stakeholders (such as senior leaders, coworkers), or external stakeholders (such as suppliers, vendors, trades people, government agency). This creates differences in terms of how the project outcomes are translated, how translation should be shaped, and how the project contributors focus on specific groups for channelling their research or project outputs.

For instance, one of the focus groups highlighted how there are differences between having the technology and wanting to use it to produce practical impact. They identified how new technology might solve some problems but not necessarily be the most effective way to address the core problem in the industry setting. However, in terms of research, understanding impact of a new technology might be of greater interest to researchers, even though its practical relevance might not be so high. Understanding the key users or the use cases is the key here in terms of whether new technology or any proposed new solution has any practical relevance or value in real world. The group highlighted how perhaps contextualising the use and implementation of new technology with regards to specific users can help in reducing some of these misalignments between industry and research organisations.

2. Training of people in academia versus in industry

Misalignment in terms of “what” research means and “how” research is conducted, particularly in a tech-based industry. One of the groups suggested that doing a scoping project first can help in bringing people to the same page before undertaking a larger project. The scoping project can be a platform to understand both parties, to build trust and momentum between the same set of people.

3. Misalignment between tech or lab work and the real world.

This was highlighted as a key disability, as it affects the nature of collaboration, the translation, and the processes undertaken for conducting the research.

5.2 Findings from review of current literature, publications of technical knowledge, and advances in peer reviewed scientific and academic journals (Research Activity 2)

In this section, we provide a summary of the main themes produced from the review of current knowledge and advances in scientific and academic journal articles focusing on collaborations between industry and research partners in the building industry. The complete list of shortlisted articles reviewed in this section are provided in Appendix 1.

The literature review reveals that a strong global advocacy exists for blending academic rigor with industry relevance to align educational outputs with building and construction industry requirements.

1. Strong advocacy exists for blending academic rigor with industry relevance to align educational outputs with construction industry requirements.
2. Industry 4.0's potential for transforming the construction sector is acknowledged, but actual practice lags due to cultural inertia and a skills deficit among practitioners.
3. The construction industry faces a dual pressure to innovate and standardise to ensure economic efficiency, quality, and safety, further exacerbated by the impact of the COVID-19 pandemic.
4. Constructive partnerships between academia and industry are recommended to co-create knowledge and foster innovative and sustainable practices.
5. There is a call for improved performance measurement and strategic management that can support the integration and diffusion of tech innovations within the construction industry.

Additionally, we provide a list of key themes in building and construction industry research here.

1. Integration and Collaboration Between Academia and Industry:

A recurring theme is the call for closer collaboration and structured joint research projects between construction industry professionals and academia. This collaboration aims to bridge the gap between theoretical knowledge and practical applications, with special attention given to curricular development, knowledge sharing, technology transfer, and co-construction of research objectives.

2. Digital Transformation and Adoption of Industry 4.0 Technologies:

Several studies emphasise the need for the construction industry to integrate advanced technologies, such as BIM, AI, IoT, and robotics. However, there is also recognition of a cultural resistance to change, with a disparity in knowledge and skills among industry practitioners compared to academics.

3. Innovative Practices and Technology Diffusion:

Innovation within the construction industry is highlighted as a key driver for improving productivity, quality, and sustainability. Factors impacting the development and adoption of innovations include cost, competitive advantage, company culture, leadership commitment, and stakeholder satisfaction.

4. Impact of the COVID-19 Pandemic:

The COVID-19 pandemic induced a range of impacts such as project delays, workforce challenges, and disruption in supply chains. However, it also accelerated the adoption of digital tools and technologies and forced the industry to rethink health and safety practices.

5. Educational Gaps and Industry Requirements:

Research underscores significant educational gaps in topics like BIM, VDC, and advanced construction technologies. It calls for the integration of tech-focused programs and upskilling of the workforce to prepare professionals for the changing demands of the construction industry.

6. Health and Safety in Construction:

Ethnographic studies and safety-focused research highlight the importance of understanding work practices and cultural shifts to improve workplace safety. The need for actionable knowledge that combines theoretical constructs with practical applications is critical in safety management.

7. Sustainability and Environmental Considerations:

There is an increasing focus on sustainability in construction practices, driving studies on green building, life cycle assessment, and energy efficiency. Emerging trends suggest a stronger emphasis on sustainable development within construction research.

8. Project Management and Organisational Efficiency:

Several studies address project management efficiency, emphasising the benefits of early integration of design and construction processes, as well as the significance of relationship dynamics and organisational structures in achieving successful project outcomes.

9. Globalisation and Economic Impact:

The global nature of the construction industry, combined with local economic conditions, necessitates research that considers both international trends and country-specific factors in industry development and innovation strategies.

5.3 Findings from review of industry publications, industry articles and government reports about collaboration between industry and research partners in the building industry (Research Activity 3)

This literature review highlights a pressing and urgent need for effective collaboration between academia, industry, and government to address a range of challenges in Australia's construction sector. Key themes include the imperative for digital transformation and adoption of Industry 4.0 tech, boosting housing supply and affordability, improving sustainability and design standards, overcoming barriers to innovation, and addressing workforce development and skills training. Reports advocate for varied strategies, from integrated project delivery methods to investments in educational programs and advanced manufacturing techniques, to ensure the sector's competitiveness and its ability to meet future demands.

Through qualitative analyses, we analysed this literature to produce a review. Before we highlight the topics that emerged from this review, we would like to highlight that multiple industry reports and government agencies highlighted the urgent need to support collaboration between industry and academia in Australia and in building industry to solve many problems that the industry and policymakers are facing. Multiple articles emphasised on the mutual benefits from university-industry partnerships, with stressed importance on joint research and knowledge exchange required for producing public and commercial good.

We summarise below the key first and second order themes from this collection of literature to provide readers with a broad overview.

Topics/Themes in Building Industry that require urgent research collaborations:

	<p>Digital Transformation</p>	<ul style="list-style-type: none"> • An evident digital maturity gap across companies of different sizes. • A strong impetus within the industry to enhance digital capabilities.
	<p>Housing Supply and Affordability</p>	<ul style="list-style-type: none"> • Government measures to incentivise higher housing production to meet demand. • Prefabrication as a solution to accelerate housing provision and affordability
	<p>Sustainability and Design</p>	<ul style="list-style-type: none"> • The construction sector's insights view the industry as unsustainable based on current practices. • The promotion of green building practices and sustainable urban development.
	<p>Workforce Development</p>	<ul style="list-style-type: none"> • Need for skills enhancement, especially in digital technologies and sustainability. • Specific measures to address skills shortages, encourage female participation, and harmonise industry and academic education standards.
	<p>Barriers to Innovation</p>	<ul style="list-style-type: none"> • Low investment in R&D within the building and construction industry. • Calls for the industry to unite around a strategic approach to innovation.



Procurement and Contract Management

- Assessment of collaborative and contractual practices to improve infrastructure project delivery.



Infrastructure and Market Capacity

- Evidence-based analysis of demand-supply constraints in public infrastructure.
- Strategic recommendations to boost labour supply, technology adoption, and productivity.



Safety and Quality Controller Measures

- The role of technology in improving construction quality and safety, with a focus on BIM and data management.



Industry Competitiveness

- The need for sector diversification and better management of development-ready land.
- Strategies for talent acquisition and market adaptation in line with global best practices.



National Policy and Strategic Action

- Recognition of national coordination efforts to address the housing crisis and housing system challenges.
- Regional housing solutions involving medium-density developments and community partnerships.



International Perspectives

- Discussions on the global housing crisis and the broader implications for social equity and economic mobility.

The industry reports and government articles collectively illustrate a dynamic and evolving industry and sectoral environment where industry players are called upon to navigate an array of competitive, economic, technological, regulatory, and societal shifts. Addressing these issues requires an integrative approach which brings together industry and research stakeholders along with policymakers, to calibrate policy, education, and industry practices to foster a sustainable, innovative, and prosperous construction sector.

5.4 Findings from participant survey (Research Activity 4)

In this section, we provide key findings from the survey we conducted before the launch of the first professional development program (Base program for researchers). Since we received only 14 responses including 4 incomplete responses, we are providing a broad overview of the findings here without delving too much into participant/sample description to mitigate and avoid any risks for potential participant identifications.

Sample Descriptions and Response Rates:

Average age of this sample was 30 years, with healthy representation from both male and female respondents (42% of the sample was female). All participants identified as individuals working in a core research job at a university or research organisation affiliated with B4.0 CRC.

Academic Work Conditions:

With regards to academic work context, here are some findings—regarding time pressures and performance pressures, 8 out of 14 participants recognised working under high time and performance pressure conditions. Ten respondents reported feeling rushed at work constantly. Seven participants reported feeling stressed at work. Nine participants reported not having enough time at work to undertake all academic activities.

Support for Academics from Leadership and Industry:

Relating to support from leadership and others for research applications, 10 participants responded that they find it difficult to gather industry support (such as sponsorship, funding, data access) for research projects in general, and 9 reported about finding it difficult to gather resources (such as capital/budget, staff time) for adopting research-based solutions in industry.

Seven participants highlighted that they find it challenging to visualise how they can practically implement their existing research projects in creating industry solutions.

5.5 Findings from in-depth explorative qualitative study (Research Activity 5)

Participants identified the following factors that influence the translation and adoption of research. Please note that quotes were paraphrased to protect participants' identities.

1. Co-creation of research among institutions (industry, academia, and CRC)

- Super teams describe teams that understand academia (e.g. research requirements and university systems such as ethics) and also industry. They're a bridge and they can quickly mediate and negotiate. They are teams that are dedicated to specific industry, government, and external engagements.
- Teams with experience on both sides are usually the most successful.
- Industry partners who are interested in research have a different business model. That is, they allocate budget for research. Success involves working with them to identify deliverables of value to them, balancing what's useful for the partner and what's useful for research.

2. Co-creation of research under CRC Vs. Non-CRC

- Stakeholder alignment can take a long time, negotiating factors such as contractual obligations, compliance, ethics approvals, commercial-in-confidence and IP.

Recommendation: Super teams

- It can be hard for a project manager to lead collaborative research because they lack industry understanding and knowledge. It's also hard to find a researcher with industry understanding and project skills. It's important to have someone who can bridge industry and research.

Recommendation: Similar to the above recommendation. Creation of Project Manager role that can act as mediators, bridge the gap between industry and academia. This is also needed to help ease admin load and tasks.

- The person leading must be very engaged with the stakeholders and the project to deliver project objectives.

3. Translation of existing research and knowledge or practice

- Undertaking research involves risks and trade-offs. The research can be very detailed at the start and translating it into impact can be difficult.

- Not all research will lead to a demonstration project or a prototype. And many of the topics explored by the CRC are new topics, which can need time (e.g. 1–2 years) to scope the research topic before reaching testing or prototyping.

4. Adoption of research-based knowledge and practices in industry

- Industry partners can be reluctant to be a test case. A new method or new product may not deliver all the promised benefits the first time because there are lessons to learn during implementation. Feedback from industry partners is that the research didn't save them what they were promised.

5. Creating research projects for impact in practice

- Having a 100% defined minimum viable product that the industry needs at the beginning of the research can be difficult. For example, the research may indicate a better way to go.
- Industry partners are looking for the research that they support to provide them with insights or evidence to change a behaviour or practices.

6. Facilitating dissemination of new knowledge and adoption of new research

- Written milestone reports and visual formats (e.g. PowerPoint) are useful.

Recommendation: Visual formats and aids

- Reports written using plain language are important for stakeholders, such as partner organisations, government, suppliers, or clients.

Recommendation: Create easy to understand findings in reports with clear recommendations written in a less technical way for most people to understand and implement.

- A prototype is not necessarily the only way to showcase new research. Findings could be disseminated via a showcase, an event or talks. It is difficult to capture some of the intangible benefits generated from the research.
- A prototype doesn't need to be physical prototype. For example, digital prototyping (such as software or interfaces) could be quite valuable, and provides a tangible outcome that could influence industry practice beyond the life of the CRC.
- Industry partners can be under pressure (e.g. from boards) to demonstrate that research they fund is impactful. Measuring and describing impact has been a journey for industry partners.
- An industry partner considered the CRC did not think about impact from the outset. The CRC is now at the point where they have to demonstrate the value of the investment, both from industry partners and the Commonwealth Government.

7. Upskilling researchers for engaged research in collaboration with industry

- Equipping researchers with 'soft skills' is important – e.g. diplomacy skills when engaging with industry partners.

8. Upskilling industry leaders to engage with academia

- Industry leaders will benefit by learning more about the research and development activities in their respective sectors so to see how value can be created in the long-term through R&D.
 - o Researchers reported often dealing with a representative of a broader group or bigger organisation who might not always advocate for evidence-based research or collaborations with a research institution that could undermine industry-research partnerships and CRC efforts.

9. Implications for early career researchers

- Leaders on projects such as CRCs and other industry-based projects may not recognise the needs of ECRs (Early Career Researchers), and so may struggle to get their full engagement. Senior researchers need to understand from the outset what ECRs need to progress in their careers (e.g. producing papers).
- Project teams should include a combination of junior and senior staff, so ECRs receive that important mentorship component.
- ECRs can also bring different ideas, so a mix of junior and senior staff is good.
- Project leaders must engage with stakeholders to ensure deliverables are delivered.
- ECRs benefit from access to a range of projects that allow them to build their reputation and profile. This helps build partnerships and when they apply for funding for future projects.

10. Implications for industry and practice

- Balancing industry objectives and research objectives can be challenging. Industry partners need a solution that addresses their problem, but researchers cannot provide a specific solution if not supported by genuine research. (That is, sometimes the research does not support the outcome the industry partner envisaged.) This situation can be challenging when industry partners provide funding.

Recommendation: Clearly communicate that research is distinct from consulting work and set appropriate expectations regarding its scope and deliverables.

- Industry expectations (about results and timelines) may be too high. Researchers need to be able to explain why the research is not going as fast as industry partners would like or why certain things are not possible.

11. Implications for Australian Building Ecosystem

- Compared with R&D culture and tradition in big US companies, Australian industry lacks investment, commitment and leadership, in terms of investing in research and implementing research outcomes in practice. There are examples of champions in US companies who drive research and reach out to universities.

5.6 Findings from professional development programs (Research Activity 6)

Case Development Method: The case studies on the Base and Trek programs were developed using descriptive case study methodology. The process begins with clearly defining the participant's learning goals, barriers, problems and challenges.

Data regarding participants were collected during their involvement in various structured developmental activities within the programs, including one-on-one coaching, peer coaching, cohort-based workshops, feedback mechanisms, and direct interactions between academic and industry partners.

The outcome is evaluated based on the programs' effectiveness in achieving participants' learning objectives and addressing identified barriers, problems and challenges. Finally, the outcome also highlights supplementary benefits beyond those previously outlined.

BASE PROGRAM CASE STUDY 1

Background context: A Higher Degree by Research (HDR) student is working on a research project to understand the use of IoT (the Internet of Things) in enhancing inclusivity within the built environment. Outputs from the research could contribute to developing guidelines for incorporating Sustainable Development Goal (SDG) 11.3 “Inclusive and Sustainable Urbanisation” into building design.

Participant’s learning goals: The HDR student identified architects as potential end-users of the research output and was motivated to develop skills and networks to build engagement with this stakeholder group.

Barriers, problems, challenges: The Base Program surfaced the HDR’s assumptions about the proposed value of the research output for the target research end-user. In particular, the HDR student realised they were unable to adequately articulate their responses to questions such as: What would motivate architects to use guidelines that incorporated inclusive design? What problems are architects currently experiencing in achieving SDGs? How do we get building designers interested in incorporating sustainability goals?

Outcome: The Base Program enabled the HDR student to take steps to validate their hypothesis about the potential value of their research output prior to guideline development. During the Base Program they committed to attending the Sydney Build Convention, to test their hypothesis via direct conversations with architects.

Keywords/Tags/themes:

problem discovery, understanding the ecosystem of stakeholders, research end-user engagement.

BASE PROGRAM CASE STUDY 2

Background context: An HDR student is researching productivity in the construction sector—specifically from a design engineer’s perspective.

Participant’s learning goals: The HDR’s research aims were: 1) defining and measuring “productivity”, and 2) building and deploying software to measure and improve productivity during the building design and construction phase.

Barriers, problems, challenges: The HDR’s research surfaced an inconsistency in the definition and practices of ‘productivity’ between academic literature and the priorities of the building sector. Although the research project has industry partner involvement, it has been difficult to gain active engagement and participation in the research activities from the broader staff at the industry partner’s organisation in ‘productivity’. Through the Base Program, the HDR student realised that the potential for research translation of building productivity management algorithms has been based on a set of un-tested assumptions about the end-user’s needs and motivations.

Outcome: The Base Program enabled the HDR student to observe and reflect on behaviours within the construction industry, and how the industry players’ definition and measurement of productivity might differ from their intentions.

Keywords/tags/themes: academic literature versus practice gap, intention versus behaviour gap, end-user engagement.

BASE PROGRAM CASE STUDY 3

Background context: An HDR student is working on a research project relating to safety in crane operations. This project was inspired by their noticing that crane drivers often do not have visibility on the crane's payload.

Participant's learning goals: Recognising a gap in the current practices, the HDR student is motivated to see their research contribute to the development of new safe practices and assistive technologies to enable the crane lift team to effectively work together. Currently, crane drivers are instructed via radio communication from other on-site workers.

Barriers, problems, challenges: The HDR student identified a culture of rejecting innovation in favour of repeating known procedures. Throughout the Base Program, the HDR student mapped out the complex relationships between stakeholders that discourage the adoption of new technologies and procedures.

Outcome: The Base Program highlighted for the HDR student a systematic approach to analyse the process of introducing new technology into an organisation. They expanded their approach to devising strategies for supporting culture change by exploring relationships between stakeholders in a structured human-centred framework of mapping the tasks, barriers, and considerations of each stakeholder. They are currently applying their learnings to engage a stakeholder in starting a joint research project.

Keywords/tags/themes: organisational culture, change management, addressing barriers to change.

TREK PROGRAM CASE STUDY 1

Background context: An early career researcher (ECR) had recently initiated a relationship with an industry partner to stand up a new collaborative project. This 18-month project focused on developing sustainable 3D printed concrete structures for civil drainage applications, involving design and prototyping. While the research project held great potential, the early-career researcher recognised the complexity of managing the different needs and expectations of university, industry and CRC stakeholders.

Participant's learning goals: The researcher's motivation for joining the Trek Program was to develop the skills and confidence necessary to lead and facilitate discussions and engagement with the industry partner. Their aim was to smoothly initiate the collaborative research project while ensuring that the project aligned with the expectations of all stakeholders.

Barriers, problems, challenges: The researcher faced two major hurdles:

- Managing expectations: balancing the divergent expectations of stakeholders, including university, industry, and CRC representatives, posed a significant challenge. Each party had its own priorities, which made aligning everyone's vision for the project difficult.
- Navigating IP discussions: early-stage IP negotiations were a critical issue. The researcher needed to engage in these discussions while simultaneously building trust with new stakeholders—a balancing act that required sensitivity, clear communication, and strategic thinking.

Outcome: Through the Trek Program, the researcher gained 'real-time' peer-coaching and feedback on how they might lead discussions with the various stakeholders towards a joint outcome in a timely manner. Through cohort-based workshops and one-on-one coaching, they developed:

- The confidence to lead complex discussions with stakeholders
- Tools to clarify the specific needs and expectations of the industry partner, ensuring alignment on project goals

- Skills to present a compelling value proposition that resonated with various stakeholders, helping to navigate IP concerns without compromising trust-building efforts.

As a result, the collaboration advanced without significant roadblocks, ensuring that all parties were aligned on the project's vision and goals.

Through the Trek Program, they not only gained critical project management skills but also built stronger relationships with stakeholders, positioning themselves as a confident leader in collaborative research.

Towards the end of the Trek Program, they successfully commenced the collaborative project and strengthened their ability to lead and manage collaborative research projects.

Keywords/tags/themes: complex stakeholder management, influencing through aligning goals and vision, time investment, trust building.

TREK PROGRAM CASE STUDY 2

Background context: An educator at a vocational training education institute was tasked with two major responsibilities: leading the development of new offerings for industry professionals in the building and construction sector on digital technology; and evaluating whether the institute's current Learning Management System (LMS) would effectively support these new offerings. However, the educator faced internal reluctance from colleagues to adopt new technology. This posed a challenge to the successful implementation of these initiatives.

Participant's learning goals: The educator joined the Trek Program to build skills in market validation and to develop a clear strategy for engaging colleagues in this process. Specifically, they aimed to understand the drivers for and barriers to technology adoption within the organisation and to learn how to communicate compelling value propositions for new service offerings.

Barriers, problems, challenges: They encountered several significant hurdles:

1. Change reluctance: Time-poor educators were comfortable with the existing LMS and hesitant to explore new technologies. Without a clear incentive for change, engaging these colleagues in testing new tools seemed difficult.
2. Market discovery conversations: They lacked confidence in conducting market discovery conversations to validate the need for new course offerings and gather insights from potential users.

Outcome: The Trek Program provided a structured approach to help the educator develop the skills needed to address these challenges. Through a combination of cohort-based learning and one-on-one coaching, the program helped them:

- Identify a small group of 'early adopters' within the organisation who were willing to engage in exploring new technology solutions. This strategy enabled the educator to gain insights into the drivers for and barriers of technology adoption without overwhelming the broader group.
- Gain skills and practice in communicating their impact vision effectively, making the case for why the new digital technology offerings were essential for the future of the industry.
- Build confidence in conducting market discovery conversations to validate the need for new course offerings and gather valuable feedback from users.

Keywords/tags/themes: market discovery skills, internal stakeholder management, influencing skills, communicating impact vision, early adopter identification, addressing change reluctance.

6. CHALLENGES FOR DEVELOPING COLLABORATIONS BETWEEN INDUSTRY AND ACADEMIA

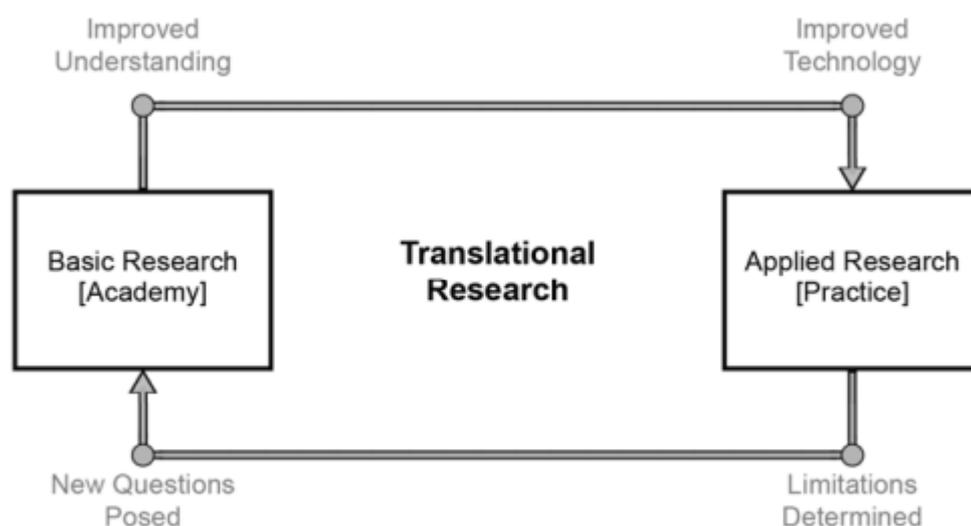
Based on our findings and recommendations from the researchers and industry leaders, in this section, we present a few selected successful frameworks for shaping, framing, and tracking research impact for research–industry collaborations from building industry and another industry (healthcare sector), which are relevant to the building research–industry collaborations.

Afterwards, we present a proposed framework that is tailored for shaping and managing the research–industry collaborations in building and construction sector. We prescribe the future research and engagement managers/leaders to further revise the proposed framework to enhance its fit for their purposes in their respective institutional settings.

6.1. Existing Frameworks from the Building and Construction Sector

The Translational Research Culture Framework (Donofrio, 2013), developed for the architecture and building disciplines, provides a structured approach for moving research from academic outputs into industry-adopted solutions with measurable real-world impact. It begins by identifying the inputs and capacity required for translation: skilled researchers, robust infrastructure, funding, and established industry networks, forming the foundation for effective collaboration.

Figure 2: General translation research model in architecture between the academic and practice



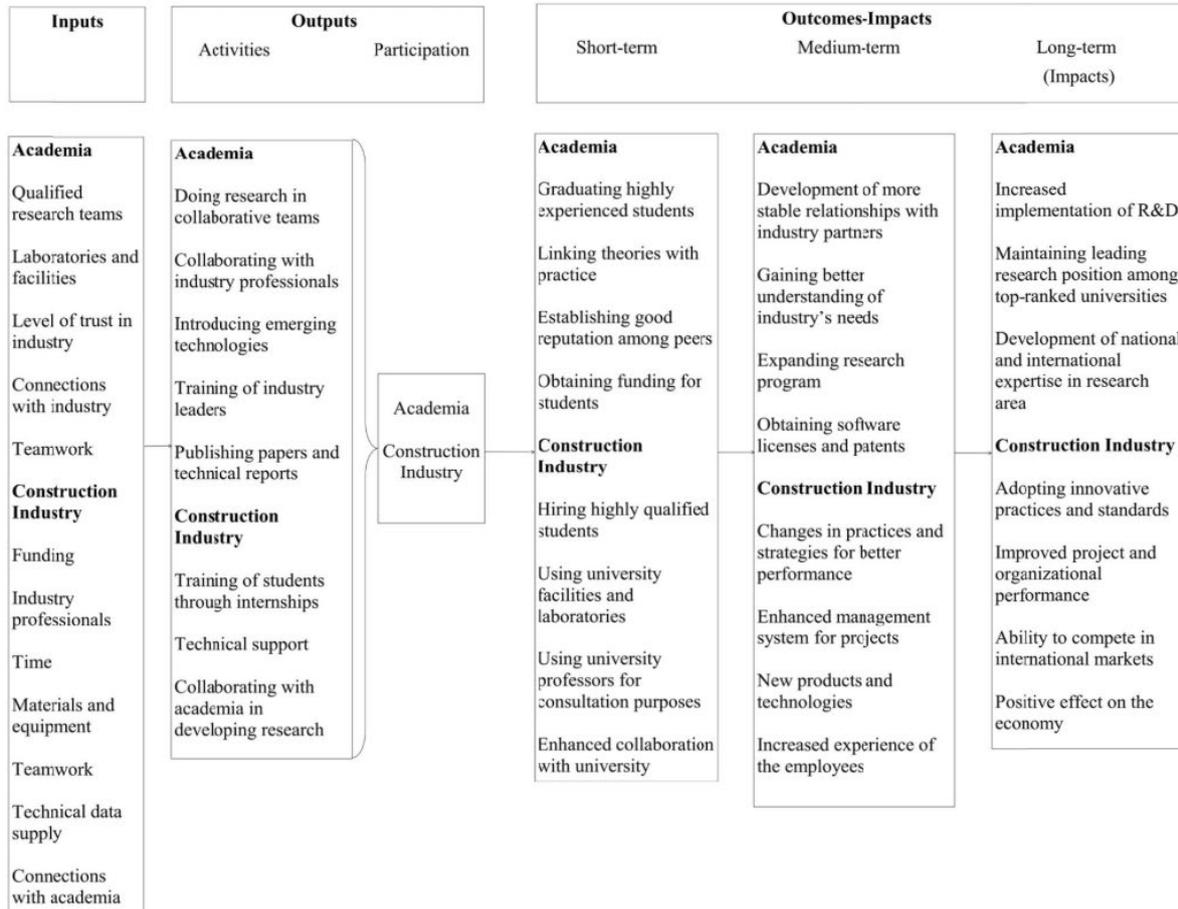
Source: <https://www.arcc-journal.org/index.php/repository/article/download/106/79> (Date of Access: 03 August 2025).

From there, it emphasises knowledge production and translation processes that go beyond traditional scholarly outputs, focusing instead on co-created projects, pilot prototypes, demonstrator buildings, and practice-ready guidelines. Engagement and feedback mechanisms are central to the model, ensuring continuous interaction between academia, industry practitioners, policymakers, and end-users to refine the relevance, usability, and performance of innovations.

The framework also defines outcomes and impacts in tangible terms: changes in professional practice, improvements in building performance and sustainability, enhanced user experience, and economic returns. Importantly, these impacts are fed back into the research cycle to shape future agendas, creating a continuous loop of improvement. Underpinning the entire process is a deliberate shift in culture and mindset, encouraging researchers to embed translational goals early, value

industry partnerships, and align success measures with both scholarly merit and practical adoption. By integrating these elements, the framework bridges the persistent gap between design research and construction practice, enabling academic inquiry to directly influence and improve the built environment.

Figure 3: Framework for Knowledge Diffusion, Outcomes and Impacts



Source:

https://www.academia.edu/34310169/Framework_for_Assessing_the_Impact_of_Construction_Research_and_Development_on_the_Construction_Industry_and_Academia (Date of Access: 03 August 2025).

The above framework offers a structured, program-logic model for understanding and evaluating how collaborative R&D between academia and the construction industry translates into tangible short-, medium-, and long-term impacts for both sectors. It begins with clearly defined Inputs, which represent the foundational resources and conditions each partner brings to the collaboration. For academia, these inputs include qualified research teams, laboratory and facility access, strong internal teamwork, and pre-existing connections with industry. For the construction industry, inputs consist of funding, skilled professionals, technical data, materials, equipment, and established links to academic institutions. These resources create the capacity to initiate collaborative research projects.

From these inputs flow Activities and Outputs, which encompass both the research work itself and the direct participatory engagements between the sectors. Academic activities include conducting research in collaborative teams, introducing emerging technologies, training future leaders, and producing scholarly outputs such as papers and technical reports. The construction industry contributes through providing internships, technical support, and active collaboration in research design and development. Crucially, this stage blends knowledge creation with knowledge exchange, ensuring that research outputs are not just academic artefacts but are shaped by industry relevance.

The framework then traces a progression into Short-Term Outcomes, which are immediate and measurable benefits to each partner. Academia benefits from graduating highly skilled students, strengthening the integration of theory and practice, enhancing its reputation, and attracting funding. The construction industry gains by hiring qualified graduates, using university facilities and expertise, and fostering enhanced collaboration with academic partners.

Medium-Term Outcomes capture deeper, more systemic changes that emerge as the collaboration matures. For academia, this includes building stable, long-term relationships with industry partners, gaining a nuanced understanding of industry needs, expanding research programs, and securing software licenses or patents. For the construction industry, medium-term impacts include improved practices and strategies for performance, adoption of enhanced project management systems, development of new products and technologies, and an increase in the collective experience and skills of its workforce.

Finally, the framework culminates in Long-Term Impacts, representing enduring changes at both institutional and sectoral levels. Academia's long-term gains include sustained R&D implementation, maintaining a competitive research position among top universities, and developing recognised national and international expertise in specific research domains. For the construction industry, these impacts translate into the adoption of innovative practices and standards, significant improvements in project and organisational performance, the ability to compete successfully in international markets, and positive contributions to the broader economy.

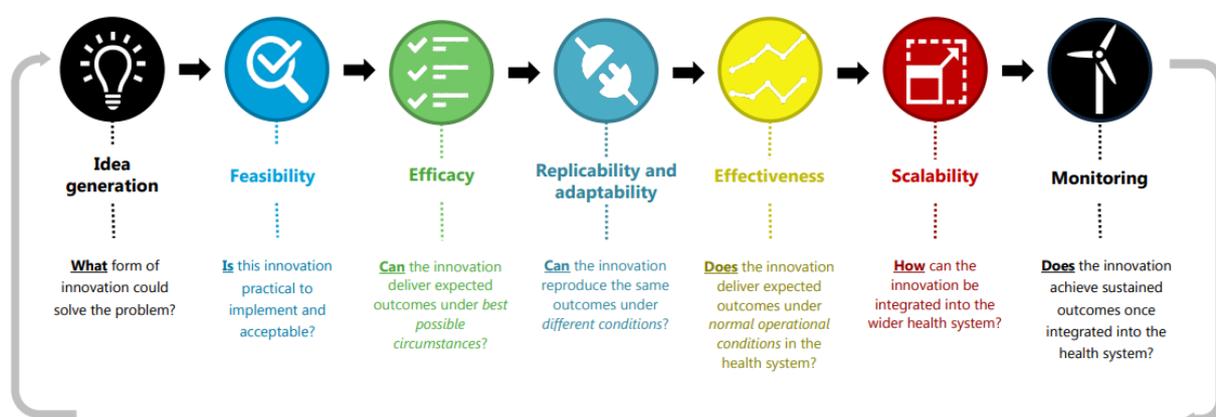
A defining strength of this framework is its explicit mapping of parallel and interconnected benefits for both academia and industry. It recognises that successful research translation in the construction sector relies on reciprocal value creation: academia gains relevance and resources, while industry gains innovation and competitive advantage. By structuring the process from inputs through to long-term impacts, the model provides both a diagnostic and a planning tool for maximising the mutual benefits of construction R&D partnerships.

6.2. Existing Frameworks from the Healthcare and Medical Sector:

The Healthcare Translational Research Framework provides a staged approach for moving innovations, whether a health service, program, policy, or technology, from concept to sustained real-world impact. For researchers and industry practitioners, this framework serves as both a roadmap and a common language for collaboration.

It compels researchers and industry partners to look beyond proof-of-concept studies and consider, from the outset, the practical realities of implementation, scalability, and sustained use. Industry practitioners, in turn, can use the staged structure to articulate operational requirements, regulatory constraints, and market conditions that will influence success at each step.

Figure 4: Translational Research Framework: testing policy, program and service innovations



Source: <https://www.medicalresearch.nsw.gov.au/app/uploads/2019/02/Translational-Research-Grants-Scheme-translation-research-framework.pdf> (Date of access: 03 August 2025).

It begins with Feasibility, assessing whether an innovation is practical to implement, acceptable to stakeholders, and safe in the intended context. Once feasibility is established, Efficacy testing examines whether the innovation can deliver its intended outcomes under optimal conditions, often with controlled variables and carefully selected participants.

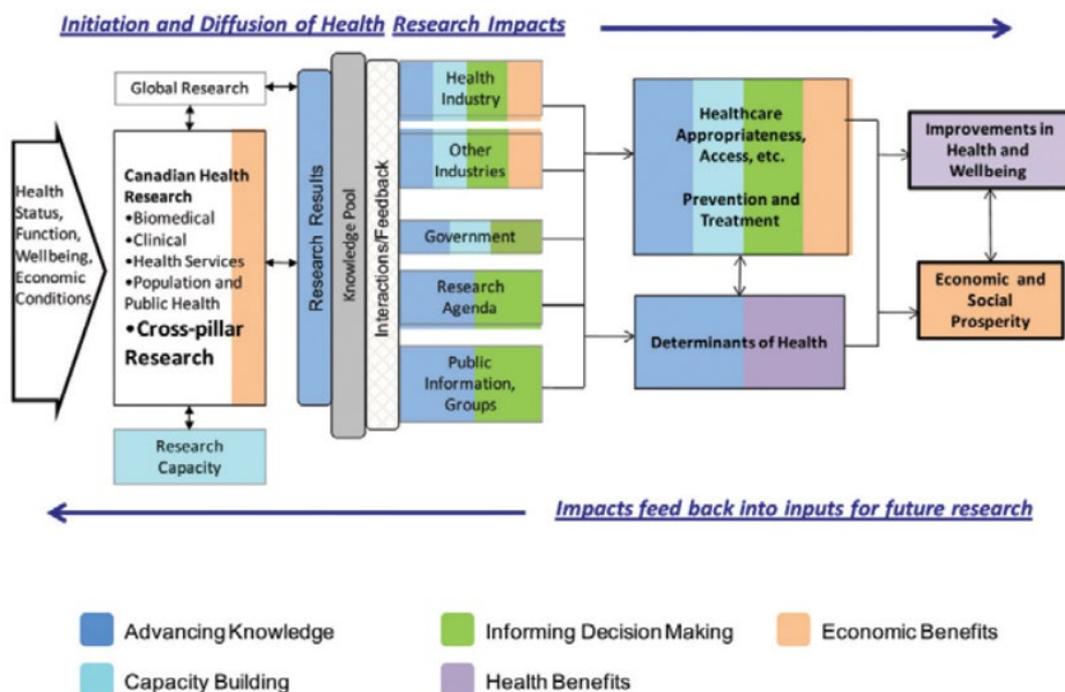
The next stage, Replicability and Adaptability, evaluates whether the innovation can produce comparable results in different settings, populations, or operational environments, while identifying any modifications required. Effectiveness testing follows, measuring performance under normal, real-world conditions with representative participants, providing evidence of how well the innovation works outside controlled environments.

If proven effective, the focus shifts to Scalability, integrating the innovation into broader health systems or larger populations while retaining quality, effectiveness, and fidelity. Finally, Monitoring ensures that the benefits are sustained over time, capturing ongoing data to inform adjustments and stimulate further rounds of translational research.

This stepwise approach recognises that translation is not strictly linear; some stages may be bypassed, revisited, or adapted depending on context, available evidence, and sector specific constraints.

Another useful framework to embrace is from the Canadian Academy of Health Sciences.

Figure 5: Canadian Academy of Health Sciences Research Framework logic model – cross-pillar research



Source: <https://aamri.org.au/advocacy/research-impact/research-impact-framework/> (Date of Access: 03 August 2025).

The Canadian Academy of Health Sciences (CAHS) Research Framework for cross-pillar research provides a comprehensive logic model illustrating how health research progresses from initial inputs to meaningful societal impacts. It captures the interconnected nature of biomedical, clinical, health services, population and public health, and cross-pillar research, recognising that impactful outcomes emerge from a dynamic, multi-stakeholder system rather than a linear sequence. The model begins with foundational inputs such as research capacity, including skilled personnel, robust

infrastructure, and sustainable funding, and the broader context of national health status, wellbeing, and economic conditions.

From these foundations, Canadian health research generates outputs in the form of research results and contributions to a shared knowledge pool. These outputs are not isolated but are constantly refined through feedback and interaction with a broad range of end-users. Stakeholders include the health industry, other industries that may apply health research innovations, government bodies influencing policy and resource allocation, organisations shaping future research agendas, and public groups that can use the information to drive behavioural change. This deliberate inclusion of multiple sectors reflects the framework’s recognition that effective research translation requires collaboration beyond traditional academic boundaries.

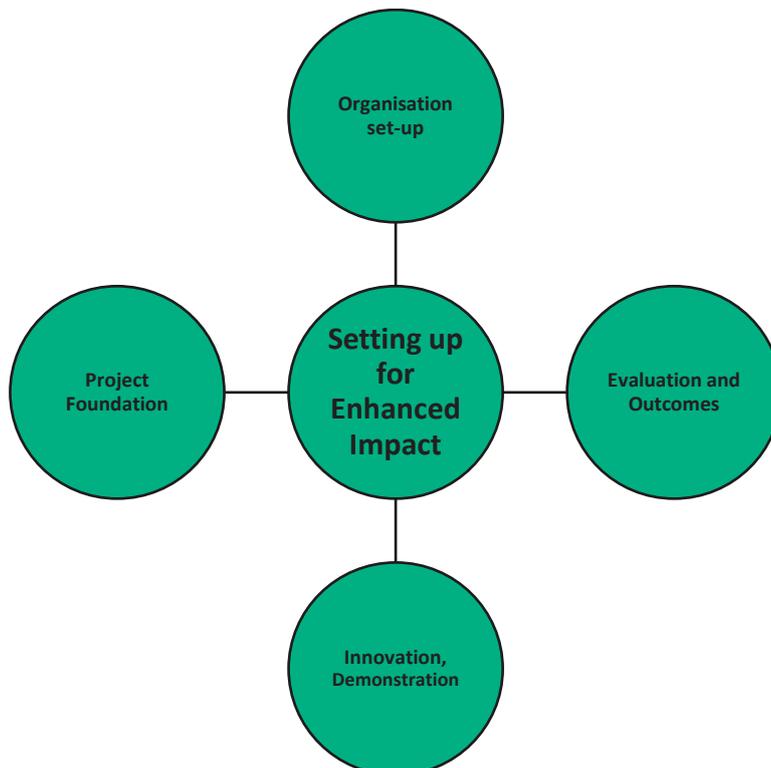
The model shows how these interactions lead to intermediate outcomes in two core domains: improved healthcare appropriateness, access, prevention, and treatment; and positive changes in the determinants of health, such as social conditions, environmental factors, and health literacy. These intermediate outcomes act as the bridge between research activity and the ultimate long-term goals of enhanced health and wellbeing, along with greater economic and social prosperity.

A key strength of the CAHS framework is its cyclical nature. Impacts are not viewed as an endpoint but as contributors to the next cycle of research, feeding back into the system to inform new priorities, strengthen capacity, and refine methods. The framework also categorises impacts into six broad domains: advancing knowledge, building research capacity, informing decision making, achieving health benefits, generating economic benefits, and delivering social benefits. By explicitly linking these domains with the pathways of influence and feedback loops, the model provides both researchers and industry practitioners with a structured yet flexible tool to plan, evaluate, and communicate the real-world value of research.

6.3. Proposed Research–Industry Engagement Framework

Informed by the findings and insights from this project, we suggest a framework for framing, managing and tracking impact for research–industry collaborative projects that is tailored specifically for the building and construction industry.

Figure 6: Research–Industry Engagement Framework



A. ORGANISATIONAL SET-UP

1. Ecosystem Engagement – cyclical structure

- Emphasise the continuous nature of research translation, with impacts feeding back into inputs for future projects.
- Number and diversity of stakeholders involved in the project
- Frequency of networking events and collaborative workshops
- Level of engagement from broader industry experts
 - At the beginning, during, and after

2. Skill Development and Knowledge Transfer

- Number of training sessions conducted for researchers on practical impact
- Presence of "super teams" with cross-sector experience
- Skills gap analysis and subsequent training programs implemented

3. Resource Allocation

- Percentage of time allocated for industry engagement by researchers
- Success rate in securing industry support (funding, data access, etc.)
- Balance between academic outputs (publications) and industry-focused deliverables

4. Risk Management and Cultural Shift

- Presence of risk mitigation strategies for new technology adoption
- Changes in organisational policies to support innovation
- Surveys measuring shifts in risk perception and innovation readiness

B. PROJECT FOUNDATION

1. Goal Alignment

- Clarity of project goals and expectations as reported by all stakeholders using SMART goals
 - Clearly shows benefits for both sectors at each stage
- Degree of alignment between academic objectives and industry priorities (outlining clear differences between research activities that is core, applied, and translation of research)
- Percentage of project outcomes addressing real-world industry problems
 - How this is to be realised within the project timespan and afterwards
- Regularity of goal review and adjustment sessions
 - Including spaces for accommodating any unexpected movements/results

2. Communication Effectiveness

- Presence of a designated "translator" or liaison between academia and building industry
- Frequency and quality of cross-sector meetings and updates
 - Outlining the structure of such communications. E.g. who attends such meetings, how the reporting of such updates is structured for both partners
- Use of accessible formats (e.g. visual aids, plain language reports) for disseminating findings

3. Project Structure and Support

- Presence of structured joint research project frameworks
- Availability and utilisation of bridging organisations or consultants
- Illustrate how feedback loops will work
 - How unexpected results, outcomes and impacts inform project progress, next steps, future research and collaboration
- Level of institutional support for this collaboration
 - Securing executive mandate and managing senior leadership support

C. INNOVATION AND DEMONSTRATION

1. Innovation Adoption

- Number of innovation trials initiated
- Rate of adoption of research outcomes in industry practices
- Regulatory changes influenced by research findings

- Include academic, industry, societal, and economic innovations/impacts, aligning with the CAHS model

2. Technology Integration

- Rate of digital technology adoption in collaborative projects
- Measures of digital maturity improvement in participating organisations
- Number of new technologies successfully integrated into industry practices

D. EVALUATION AND OUTCOMES

1. Practical Demonstration

- Number of prototypes or proof-of-concepts developed
- Frequency of showcase events demonstrating research applications
- Industry feedback on the relevance and applicability of demonstrations

2. Short, Medium and Long-term Impact Assessment

- Tracking of project outcomes 6, 12 and 24 months post-completion
- Changes in industry practices attributable to research collaboration
- Economic impact of implemented research findings

3. Stakeholder Engagement and Satisfaction

- Regular surveys of all stakeholders on project progress and outcomes
- Net Promoter Score for likelihood of future collaborations
- Qualitative feedback on the value derived from the collaboration

By incorporating these markers and indicators into a research and practical impact framework, project leaders can more effectively monitor, manage and maximise the outcomes of university-industry collaborations. This framework provides a holistic view of the collaboration's success, encompassing both academic rigour and practical industry relevance.

7. OVERCOMING CHALLENGES DURING COLLABORATIONS BETWEEN INDUSTRY AND ACADEMIA

Below are recommendations for different contributors in the industry and research innovation ecosystem:

For leaders and management at research institutions, e.g. universities:

- Increase frequency of touch points between academics and industry.
- Recognise industry engagement in workload allocation.
- Establish funding programs explicitly for secondment of academics (teaching backfill) to perform translation opportunity identification and validation, linked to mandatory participation in structured support and skill-building programs.
- Recognise efforts towards industry engagement and research translation in academic performance and promotion frameworks.
- Increase opportunities for research consulting engagements for ECRs.
- Increase academics' awareness of industry/sector-level committee membership opportunities that require research expertise, such as advisory roles.
- Increase academics' awareness of speakership opportunities at industry conferences and events, support academics to increase their external visibility to organisers of these events.
- Support academics to co-author industry-facing articles and publications with industry partners.
- Support academics to co-design project proposals with industry partners.
- Support HDRs and academics to have informal discovery conversations (outside ethics-approved research interviews) with industry partners about construction industry challenges (e.g. to contrast the academic definition of 'productivity' with how a construction manager might actually operate project management software or excel spreadsheets).
- Introduce an evidence-based translation-readiness assessment framework to guide design of the translation support ecosystem, to identify high-impact-potential projects for allocation of support resources, and to guide researchers in translation.

For innovation leaders in industry responsible for leveraging research capability to unlock growth in their organisations:

- Increase opportunities for industry professionals to undertake PhDs (e.g. PhDs in practice).
- Support industry professionals (project leaders) to gain experience and capability in validating customer need and developing business cases for R&D investment.
- Align innovation investment with business strategy and outcomes through championship from leadership at executive level.
- Support executive leaders to build relationships with their peers in academic research to jointly identify 'megatrends' that might affect the business and innovations that will allow the business to flourish.
- Gain capability and experience in collaborating with appropriately skilled researchers to address these innovation challenges.
- Gain capability and experience in defining research translation proof-of-concept projects to address these innovation challenges, and managing researchers' timely execution of these projects.
- Gain capability and experience in identifying the role that intellectual property (IP) plays in capturing these opportunities and creating and supporting the protection of this IP.

For leaders and management at CRCs:

- Support impact and outcome reporting for CRC projects.
- Develop impact framework for CRC and require CRC projects to articulate the alignment and contribution to the impact goals of CRC.
- Require CRC projects to articulate impact and outcome metrics as part of project scoping.
- Require CRC projects to build in translation and commercialisation validation 'points' within the research project timeframe.
- Support researchers with capability to lead co-authorship process for project proposals.

For policymakers and administration in government responsible for enhancing industry and education outcomes:

- Facilitate whole-of-sector discussions on addressing barriers to innovation adoption.
- Enable policy reforms to accelerate innovation adoption.
- Support universities and the research ecosystem to create 'slack' in the current teaching and research resourcing system to allow more risk-taking for academics to pursue collaborations with industry and community which might not result immediately in highly cited papers.
- Reduce barriers for industry to identify and engage researchers to address innovation challenges: independent, government-subsidised industry-researcher match-making, potentially based on Scotland's Interface program, modified to initially offer each SME R&D challenge to the single university research group best-equipped to address it. This will seed long-term university-SME partnerships, rather than creating bidding wars between universities.
- Increase industry innovation and research collaboration capability through:
 - Attractive packages (including visas) to attract global technical & entrepreneurial talent with these capabilities to Australia, especially expatriate Australians
 - Structured, government-subsidised capability development (training, coaching and mentoring) programs for industry (especially SME) leaders.
- Provide resources to equip researchers to develop "ambidextrous" skills—capabilities in both discovery research and research translation- and skills to plan their research projects for impact, and to evaluate and monitor this impact. This could be achieved, for example, by supporting a government funding agency such as the ARC to run an "Impact Academy" to which all researchers applying for government research funding have access. This idea builds on the proposal from Science and Technology Australia (STA), of which Cruxes Innovation is a proud member, for the ARC to help researchers acquire science communication skills. Just as STA would be an ideal partner to deliver this training, Cruxes Innovation would be an ideal partner to deliver the broader "Impact Academy."
- To increase researcher capability to lead industry engagement and entrepreneurship: national-scale industry engagement coaching and mentoring programs for Higher Degree Research students and early-career researchers, aimed at reaching thousands or tens of thousands of researchers each year. Examples of successful international best practice include the [US National Science Foundation's I-Corps](#) and [Innovate UK's ICURe](#). Based on these examples and our Australian experience, we recommend that the programs include:
 - Regularly updated government certification of core program content and delivery personnel, to ensure and maintain uniform high quality
 - Program delivery is primarily government-funded, e.g. by extra Research Block Grant funding to universities who offer the programs
 - Universities provide sponsorship (in-kind or monetary) to their researchers who participate in the programs, to ensure that the university supports the participants and their projects.

We further expand on our recommendations below:

Co-creating research among institutions (industry, academia and CRC)

- Prioritise building interdisciplinary teams with experience navigating both academic research and industry practice. These teams can effectively mediate, negotiate shared priorities and create mutually beneficial deliverables that balance research objectives with industry requirements.

- Conduct targeted information sessions on key university systems such as ethics, government engagement protocols and administrative processes to build capability and streamline collaboration.

Co-creating research under CRC Vs. Non-CRC

- Create or assign dedicated Project Managers in each project to facilitate collaboration and bridge the gap between industry partners and academics. Project Managers can alleviate the administrative burdens such as coordinating schedules, managing contracts, ensuring regulatory compliance, and monitoring progress against deliverables. This approach frees researchers and industry professionals to concentrate on research and innovation while logistical and administrative responsibilities are centrally managed.

Translating existing research and knowledge or practice

- At the commencement of every project, partners must define a clear, agreed-upon tangible deliverable that meets both the theoretical research needs of academics and the commercial objectives of industry. This deliverable could take the form of a physical or digital prototype, a demonstration or even an alternative prototyping method that aligns with the practical needs of both parties.

Adopting research-based knowledge and practices in industry

- Develop an Institutional Memory Framework system for continuity and knowledge transfer across projects to ensure that new methods, tools or innovations are given the opportunity to mature and improve over time. Without mechanisms to support iteration and embed improvements into future projects, early-stage initiatives risk being prematurely judged as failures. Continuity roles and documenting effective processes can help prevent the loss of valuable insights when teams change or new CRC projects are commenced, ensuring that promising innovations are not abandoned due to isolated implementation setbacks.

Creating research projects for impact in practice

- Regulatory bodies prioritise research that delivers actionable insights to behavioural change, informing new legislation, and updating or reshaping regulatory standards.

Facilitating serration of new knowledge and adoption of new research

- To maximise the uptake and practical application of research outcomes, findings and recommendations should be presented in a visually engaging, concise and action-oriented format. Communication should be tailored to the specific needs of three key stakeholder groups: industry, regulatory bodies and government policymakers. In the recommendations section of the report, include subheadings for each group to ensure the recommendations are targeted, relevant and actionable. Deliver Milestones Reports in visually oriented formats such as slide decks. These reports should prioritise brevity and use visual elements to clearly illustrate critical project developments. Visually oriented formats are particularly well-suited for communicating with time-constrained stakeholders and enhances the overall visibility of research outcomes.
- Develop a CRC Impact Framework, comprising two versions tailored to academic researchers and industry partners. The framework should require each research project to clearly articulate its objectives, methodological approach, intended impact measures and anticipated outcomes. Furthermore, the CRC Impact Framework should incorporate a systematic mechanism for tracking, evaluating and evidencing impact over time.

Upskilling researchers for engaged research in collaboration with industry

- Understand industry needs, particularly the commercial aspects, and how they align with research objectives.
- Equip researchers with skills in diplomacy, effective communication, presentation techniques and industry-specific presentation styles to ensure they can convey research in a way that resonates with industry stakeholders.

Upskilling industry leaders to engage with academia

- Industry leaders should have champions and advocates for research partnership.

Implications for early career researchers

- Create a clear structure and guide for mentorship between senior researchers and ECRs.
- Ensure that ECRs receive proper training in both research methodologies, presenting project managements, diplomacy and other career skills.
- Recognise and celebrate their contributions, offering them visibility and credit for their work.
- Provide opportunities for ECRs to lead.

Implications for industry and practice

- Establish a mutual understanding that research is distinct from consulting work.
- Expect appropriate expectations regarding the scope and deliverables, ensuring that both parties understand that research outcomes may include publications, data analysis and theoretical insights, which can take time.
- Additionally, industry should be made aware that academics often need to publish their findings in peer-reviewed journals, which may require a different timeline and level of detail compared with practical consulting projects.

Implications for Australian Building Ecosystem

- Establish a structured and open channel for engaging with the Building and Plumbing Commission (BPC) to facilitate researcher access to key decision makers, respond to BPC's untapped willingness to be involved in more CRC projects, and leverage their strategic connectivity to other regulatory bodies and policymakers.
- Raise up champions in the ecosystem to advocate for academic-industry partnerships
- Investment into academic-industry partnership.

8. FUTURE RESEARCH PLANS

We are keen to expand tools and frameworks that allow effective framing, measurement, and progress tracking of potential, realised, and actual research outcomes and impact in the short-term and long-term for research–industry partnerships.

We are also keen to study how the Australian building and construction sector can lead the world in sustainability practices, powered with breakthrough technology and innovative solutions. This is perhaps possible through harnessing Australian research capabilities towards addressing the innovation challenges faced by businesses and organisations in the building and construction sector.

Currently, the building and construction sector has one of the lowest rates of investment in R&D investments with an allocation of only 1-2 per cent of turnover. This compared to at least 10 percent in other mature industry sectors is very low (such as car manufacturing, technology, pharmaceuticals, and consumer electronics).

Distinguishing characteristics of an industry that is highly innovative include:

- Policy and regulation that enables fast innovation adoption and diversity of business models
- Access to a sufficient volume of technology that is mature enough for deployment at scale
- Increased consumer expectations of innovative solutions.

Research, by nature, is no crystal ball, but the building industry (the largest contributor to greenhouse gas emissions) is at an inflection point to transform itself and this is not possible without innovation across all facets.

9. APPENDICES

Appendix 1. Tables

Table 1. List of Scientific and Peer-Reviewed Journals (for literature review of scientific and peer-reviewed journal articles)

Journals	Scopus Rating
Architectural Engineering and Design Management	Q1
Buildings	Q1
Canadian Journal of Civil Engineering	Q1
Construction Economics and Building (University of Technology, Sydney)	Q1
Construction Innovation	Q1
Construction Management and Economics	Q1
Industry and Higher Education	Q1
International Journal of Construction Education and Research	Q1
International Journal of Construction Management	Q1
International Journal of Productivity and Performance Management	Q1
International Journal of Project Management	Q1
Journal of Architectural Engineering	Q1
Journal of Civil Engineering and Management	Q1
Journal of Construction Engineering and Management	Q1
Journal of Higher Education Policy and Management	Q1
Journal of Management in Engineering - ASCE	Q1
Journal of Management Studies	Q1
Procedia Computer Science	Q1
Safety Science	Q1
Science and Public Policy	Q1
Built Environment Project and Asset Management	Q2
Journal of Open Innovation: Technology, Market, and Complexity	Q2
Journal of Professional Issues in Engineering Education and Practice	Q2
Journal of Public Affairs	Q2

Table 2. List of Government Agencies and Other Sources (for literature review of industry reports and articles)

Sources or Authors	Year of Reports
AHURI	2024
ARC Communications	2024
Australian Broadcasting Corporation	2022
Australian Centre for Housing Research	2023
Australian Government	2024
Australian House of Representatives Standing Committee	2022
Believe Housing Australia	2022
Boston University	2024
Build Australia	2024
Building Commission NSW	2023
Construction Expert Working Group	2022
CPB Contractors	2024
David Chandler OAM	2024
Dr Tharaka Gunawardena, Joyce Ferng, Professor Tuan Ngo, Professor Shan Kumar, Professor Priyan Mendis	2023
Green Building Council Australia	2021
iBuild Building Solutions	2021
Infrastructure Australia	2023
Institute of Public Affairs	2023
Jones, K., Mosca, L., Whyte, J., Davies, A., Glass, J.	2021
Leigh Dawson	2021
Mark Degotardi	2024
Martin Loosemore	2016, 2019
Master Builders Association	2024
Master Builders Association Victoria	2023
Nicola Brackertz, Tom Alves, Kylie Valentine, Hazel Blunden, Megan Blaxland, Ilan Katz	2023
People's Commission and University of Sydney	2024
Ryan Johnson, Urban Development Institute of Australia (UBIA)	2024
Sam Burt	2020
Sasha Menon	2023
The University of Queensland	2024
The Urban Developer	2024
Torrens University, Australia	2021
University of Melbourne	2018, 2024
University of Newcastle	2023
UNSW Sydney	2021
Victoria State Government	2022
Will Venn	2023

Table 3. Literature Review of Scientific and Peer-Reviewed Journals

Citation	Key Findings	Geog. Region	Methodology
<p>Sacks, R., & E. Pikas. (2013). Building Information Modelling Education for Construction Engineering and Management. I: Industry Requirements, State of the Art, and Gap Analysis. Journal of Construction Engineering and Management, 139(11).</p>	<p>Industry Requirements: The study identified 39 BIM-related topics across three categories: processes, technology, and applications. These topics include the necessary skills and knowledge areas that graduates need to be effective in the construction engineering and management (CEM) industry.</p> <p>Educational Gaps: There is a significant gap between the current state of BIM education in universities and the industry's needs. Many universities offer limited BIM education, often focusing on basic modelling skills rather than comprehensive BIM processes and applications.</p> <p>Competency Levels: The required competency levels for each BIM topic were defined using Bloom's taxonomy, ranging from basic knowledge to advanced evaluation and synthesis skills.</p> <p>Implementation Strategies: Effective BIM education requires integrating BIM topics across the curriculum, starting with fundamental skills in the early years and progressing to advanced applications in later years.</p> <p>Challenges and Recommendations: Major challenges include the need for experienced educators, appropriate curriculum development, and the integration of BIM into existing courses. Recommendations for overcoming these challenges include developing structured curricula and enhancing collaboration between academia and industry.</p>	<p>United States, Israel, Brazil, Cyprus, Estonia, Norway and Portugal</p>	<p>Data Collection: Data were collected through surveys, workshops, job advertisement analyses, and in-depth interviews with industry professionals and academics.</p> <p>Survey: A detailed survey was distributed to 85 construction professionals with extensive experience in BIM. The survey aimed to identify the required BIM skills and knowledge areas for CEM graduates.</p> <p>Workshops and Forums: An international BIM Education Workshop and discussions in the LinkedIn BIM Experts group provided qualitative data on industry expectations and educational practices.</p> <p>Curriculum Analysis: Syllabi from 18 BIM courses at seven universities were examined, and in-depth interviews with educators were conducted to assess current teaching practices and identify gaps.</p>
<p>Son, J., O'Brien, W. J., & Thomas, S. R. (2022). Recommended Practices for Effective Management of Academia-Industry</p>	<p>Success Factors of AICR: The study validated success factors such as clear research scope, flexible methodology, active participation, strong leadership, and effective team dynamics. These factors were confirmed through in-depth analysis of both well-functioning and subpar-functioning research teams.</p> <p>Leadership and Team Dynamics: Dual leadership from</p>	<p>Construction Industry Institute (CII) at the University</p>	<p>Data Collection: The study employed a multi-phase methodology involving literature review, case identification and selection, detailed case studies, and consolidation of findings. Data were collected through semi-structured interviews, analysis of team documents (e.g. meeting minutes), and surveys.</p>

Citation	Key Findings	Geog. Region	Methodology
<p><u>Collaborative Research Teams in Construction Management. Journal of Construction Engineering and Management, 148(8).</u></p>	<p>both academia and industry, along with clear allocation of roles and responsibilities, was crucial. Effective leadership balanced influence and freedom, fostering team alignment and commitment.</p> <p>Methodological Rigor and Practical Relevance: Balancing academic rigor with practical relevance was essential. Well-designed research plans and methodologies that evolved based on team findings contributed to successful outcomes.</p> <p>Participation and Engagement: High levels of member participation and engagement were key to success. Teams with strong participation had better outcomes compared to those with significant attrition and lack of involvement.</p> <p>Flexibility and Adaptation: Flexibility in adapting research plans and methodologies to emerging data and findings was highlighted as a critical factor for successful collaborative research.</p>	<p>of Texas at Austin</p>	<p>Case Studies: Eleven research teams were selected for in-depth case studies. These teams included a mix of well-functioning and subpar-functioning teams, completed between 1988 and 2011. The selection criteria were based on the dissemination, implementation, and perceived value of research outcomes.</p> <p>Interviews: A total of 39 participants, including principal investigators (PIs) from various universities and industry members from CII member companies, were interviewed to gather insights into the factors influencing the success and challenges of AICR teams.</p> <p>Cross-Case Analysis: The data from individual case studies were analysed and compared to validate the research propositions and identify common success factors and recommended practices.</p>
<p><u>Azhar, S., Ahmad, I., & Sein, M. K. (2010). Action Research as a Proactive Research Method for Construction Engineering and Management. Journal of Construction Engineering and Management, 136(1), 87–98.</u></p>	<p>Action Research as a Suitable Method: The study advocates for Action Research (AR) as a suitable and effective method for addressing practical problems while generating theoretical knowledge in Construction Engineering and Management (CEM). It highlights AR's ability to bridge the gap between academic research and industry practice, making it a valuable approach for applied research.</p> <p>AR Implementation: The study illustrates AR's implementation through a case study involving the design and implementation of a data warehouse for a construction owner organisation. This example demonstrates AR's practical application and its potential to bring about significant improvements in information management and decision support systems in the</p>	<p>Florida, United States</p>	<p>Questionnaire Survey: A questionnaire survey was conducted among 550 construction owner organisations in the United States to validate the initial research hypothesis and gather data on the use of information systems for planning and decision making.</p> <p>Case Study: A detailed case study of a local public construction owner organisation in Florida was conducted. This involved enterprise modelling, developing a functional model and reference architecture for a data warehouse, and implementing organisational restructuring.</p> <p>Focus Group Discussions: The research involved focus group discussions with</p>

Citation	Key Findings	Geog. Region	Methodology
	<p>construction industry.</p> <p>Collaborative Effort: Successful AR requires a collaborative effort between researchers and practitioners. The study emphasises the importance of establishing a client-system infrastructure to facilitate this collaboration and ensure the research addresses real-world problems effectively.</p> <p>Cyclical Process Model: AR follows a cyclical process model involving diagnosing, action planning, action taking, evaluating, and specifying learning. This iterative approach ensures continuous improvement and adaptation based on feedback and reflection.</p> <p>Impact on Organisational Structure: The implementation of a data warehouse in the case study led to substantial organisational restructuring, including downsizing and merging divisions to streamline operations and improve productivity. This demonstrates AR's potential to drive significant organisational change.</p>		<p>executives from the client organisation to gather feedback and refine the research approach and solutions.</p> <p>Action Research Phases: The study followed the five phases of AR: diagnosing, action planning, action taking, evaluating, and specifying learning. Each phase involved collaborative efforts between researchers and practitioners to ensure practical relevance and effectiveness.</p>
<p>Erdogan, B., Anumba, C. J., Bouchlaghem, D., & Nielsen, Y. (2014). Collaboration Environments for Construction: Management of Organisational Changes. Journal of Management in Engineering, 30(3), 04014002.</p>	<p>Framework Development: The study developed the MOCHA (Management of Organisational Changes) framework to manage the organisational changes resulting from the implementation of collaboration environments in construction projects. This framework includes a structured approach to handle the introduction of new collaboration technologies and processes.</p> <p>Importance of Organisational and People Issues: The success of collaboration environments largely depends on addressing organisational and people-related issues rather than just technological aspects. This includes managing resistance to change, ensuring top-level commitment, and fostering user involvement.</p> <p>Stages of Change Management: The MOCHA framework comprises five primary stages: initiation of</p>	<p>United Kingdom, United States</p>	<p>Case Studies: Case studies of construction projects were analysed to identify the challenges and success factors related to the implementation of collaboration environments. These case studies informed the development of the MOCHA framework.</p> <p>IDEF0 Modelling: The framework was developed using the IDEF0 process modelling approach, which allows for a detailed representation of processes and subprocesses. This method was chosen for its ability to handle complex systems and its familiarity with construction professionals.</p> <p>Expert Evaluation: The MOCHA framework was evaluated by experts from eight construction organisations, including</p>

Citation	Key Findings	Geog. Region	Methodology
	<p>change, development of change vision, planning of organisational change, implementation of change, and evaluation of change. Each stage includes specific processes and subprocesses designed to facilitate effective change management.</p> <p>Evaluation and Feedback: The framework was evaluated through expert consultations and found to be effective in managing organisational changes. The evaluation highlighted the importance of early user involvement, clear communication, and continuous feedback for successful implementation.</p>		<p>contracting companies, architecture firms, consultancy companies, and a real estate trust organisation. Evaluation sessions included presentations, discussions, and questionnaires to gather qualitative and quantitative feedback.</p>
<p>Brochner, J., & Lagerqvist, O. (2016). From ideas to construction innovations: Firms and universities collaborating. Construction Economics and Building, 16(1), 76–89.</p>	<p>Informal Contacts as Key Interaction: Informal contacts between firms and universities were identified as the most significant form of interaction for both industry and academic respondents. This highlights the importance of building strong, informal networks to facilitate knowledge exchange and innovation.</p> <p>Diverse Interaction Mechanisms: The study found a variety of interaction mechanisms valuable, including joint research projects, staff mobility, MSc thesis work in firms, and recruitment of graduates. For universities, MSc thesis work and industrial PhD candidates were particularly significant.</p> <p>Sector-Specific Collaboration Patterns: The study revealed that collaboration patterns vary significantly across different sectors and disciplines. Manufacturing firms were more reliant on university laboratories, whereas firms in services preferred collaborations that involved shorter distances and more frequent interactions.</p> <p>Geographical Proximity: Geographical proximity between firms and universities was found to be important, especially for collaborations involving laboratory use and problem-solving tasks.</p>	<p>Sweden</p>	<p>Questionnaire Surveys: Two separate surveys were conducted in 2012. One survey targeted experienced construction sector respondents, while the other was aimed at construction researchers. The surveys collected data on preferred types of interaction and collaboration experiences.</p> <p>Case Studies: The study analysed all 16 development projects funded by the Bygginnovationen programme. This involved reviewing project documents, funding applications, and conducting interviews with project managers.</p> <p>Data Analysis: Descriptive statistics, correlation analysis, and qualitative analysis of interview data were used to identify key patterns and insights from the surveys and case studies.</p>

Citation	Key Findings	Geog. Region	Methodology
	<p>Project-Specific Insights: Analysis of 16 development projects within the Bygginnovationen programme showed that university collaboration was often driven by the need for analytical understanding, problem-solving, and field measurement. The involvement of universities provided crucial support in these areas, enhancing the innovation process.</p>		
<p>Nadim, W., & Goulding, J. S. (2009). Offsite Production in the UK: The Construction Industry and Academia. Architectural Engineering and Design Management, 5(3), 136–152.</p>	<p>Perceptual Misalignment: The construction industry and academia hold divergent views on the role and implementation of Offsite Production (OSP). While industry leaders view OSP as a critical evolution for the future, enhancing efficiency and addressing labour shortages, academia is more reserved, often questioning the scalability and sustainability of OSP's impact.</p> <p>Future Uncertainty: There's an observed uncertainty within academia about OSP's future role in the construction sector, which may stem from a lack of concrete examples of OSP's long-term benefits or perhaps a conservative adherence to traditional construction methodologies.</p> <p>Skills Shortage and Mismatch: Both sectors agree on the existence of a skills gap, particularly in areas requiring managerial and advanced technical skills. The industry points out the acute shortage of professionals who are not only technically proficient but also adept at managing OSP projects.</p>	<p>United Kingdom</p>	<p>A structured survey that targeted heads of large construction firms and directors of academic programs within construction-related fields. The study's robust quantitative analysis provided a solid base to compare and contrast the perceptions across these groups. Statistical tools were used to analyse responses and identify significant discrepancies or agreements in perceptions related to OSP between the two groups.</p>
<p>Daoud, A. O., Tsehayae, A. A., & Fayek, A. R. (2017). A guided evaluation of the impact of research and development partnerships on</p>	<p>Value of R&D Partnerships: The study highlights the significant value that R&D partnerships bring to universities, industries, and government agencies, including technology transfer, innovation, and the development of collaborative networks.</p> <p>Evaluation Framework: A specific evaluation framework using a logic model is developed and tested, enabling</p>	<p>Canada</p>	<p>Logic Model Development: The study employs a logic model for evaluating R&D partnerships. This model assesses inputs, outputs, and outcomes to establish a clear relationship among the resources invested, activities undertaken, and results achieved.</p> <p>Case Study Approach: A case study involving</p>

Citation	Key Findings	Geog. Region	Methodology
university, industry, and government. Canadian Journal of Civil Engineering, 44(4), 253–263.	<p>stakeholders to measure the effectiveness of R&D partnerships systematically.</p> <p>Gaps in Understanding and Implementation: There are considerable gaps between potential and realised outcomes in R&D partnerships, often due to misalignment of goals and expectations among the parties involved.</p>		<p>an NSERC Industrial Research Chair program serves as the primary method of testing the evaluation framework.</p> <p>Data Collection and Analysis: Quantitative data from surveys and qualitative insights from structured interviews are analysed to validate the logic model and refine the evaluation framework.</p>
Shapira, A., & Rosenfeld, Y. (2011). Achieving Construction Innovation through Academia-Industry Cooperation—Keys to Success. Journal of Professional Issues in Engineering Education and Practice, 137(4), 223–231.	<p>Successful Collaboration: The study highlights the crucial role of effective collaboration between academia and the construction industry in overcoming the inherent conservatism of the industry towards adopting new technologies.</p> <p>Innovation Development: It outlines a detailed process of innovation from conception through to commercialisation, emphasising continuous engagement between academic researchers and industry practitioners.</p> <p>Barriers and Enablers: The research identifies key barriers (like industry scepticism and technological readiness) and enablers (such as necessity and mutual benefit) that affect the adoption and implementation of new technologies in construction.</p>	Israel	<p>Case Study Approach: The methodology involved a comprehensive case study analysis of the development and implementation of the vision system. This included direct observations, interviews, and feedback collection from various stakeholders involved in the project.</p> <p>Participatory Research: Researchers actively participated in the project development, engaging with industry partners at construction sites, which provided practical insights and validation of the theoretical frameworks proposed.</p>
Sutrisna, M., Tjia, D. and Wu, P. (2021). Developing a predictive model of construction industry-university research collaboration. Construction Innovation, Vol. 21 No. 4, pp. 761-781.	<p>Influential Factors: Key factors influencing the likelihood of IU collaboration include company size, experience in the construction industry, prior IU collaboration, importance of innovation, and motivation for innovation.</p> <p>Predictive Model: A predictive model using an artificial neural network (ANN) successfully predicts the likelihood of a construction company collaborating with universities, with an accuracy rate of 85.5%. This model considers factors like company size, previous collaborations, and innovation motivations.</p> <p>Statistical Significance: The study found statistically</p>	Australia	<p>Mixed-Methods Approach: The methodology incorporated both quantitative (questionnaire survey) and qualitative (focus groups) methods, providing a comprehensive view of industry perspectives.</p> <p>Data Analysis: Data from the survey was analysed using descriptive and inferential statistical methods. The ANN model was developed and cross-validated to ensure robustness, enhancing the predictive accuracy of the factors influencing IU collaboration.</p>

Citation	Key Findings	Geog. Region	Methodology
	significant influences of the mentioned factors on the likelihood of collaboration, reinforcing the importance of targeted, strategic approaches to foster IU collaborations.		
Lavikka, R., Seppänen, O., Peltokorpi, A. and Lehtovaara, J. (2020). Fostering process innovations in construction through industry–university consortium. Construction Innovation, Vol. 20 No. 4, pp. 569-586.	<p>Effective Collaboration Model: The study developed a conceptual model that includes network architects who facilitate consortium development and a joint governance body to create a shared vision and select research topics. This model proved effective in fostering collaboration and enabling innovations in construction.</p> <p>Practical and Academic Impact: The consortium's research activities have led to both academic publications and practical process innovations in construction, demonstrating the dual impact of industry-university collaborations.</p> <p>Barriers to Innovation: Despite successful collaboration, the paper identifies several barriers to innovation in construction, primarily related to the sector's conservative nature and challenges in aligning the different operational timescales and objectives of industry and academia.</p>	Finland	<p>Design Science Research: The research was conducted using a design science approach from 2016 to 2019, aimed at creating and assessing a model for industry-university collaboration. This approach included building and evaluating a conceptual model based on empirical data.</p> <p>Mixed-Methods Data Collection: The methodology involved surveys and in-depth interviews to evaluate the academic and practical impacts of the consortium's research projects. These methods provided a robust data set for analysing the effectiveness of the collaboration model.</p> <p>Iterative Development and Feedback: The consortium's development was documented and analysed through regular consortium meetings, steering group feedback, and narrative constructions by university participants, ensuring that the research activities were closely aligned with industry needs.</p>
Voordijk, H., & Adriaanse, A. (2016). Engaged scholarship in construction management research: the adoption of information and communications	<p>Integration of Theoretical and Practical Knowledge: The research critically examines how different forms of engaged scholarship (practice research, design research, and action research) can be effectively utilised to bridge the gap between theoretical constructs and practical applications in construction management.</p> <p>Stakeholder Collaboration: The study identifies how collaborative dynamics between various stakeholders</p>	Dutch construction industry	<p>Triangulation Approach: Employing a combination of qualitative data collection methods including case studies, ethnographic observations, and expert interviews, the study triangulates data to build a comprehensive model of ICT adoption.</p> <p>Iterative Model Refinement: The use of iterative rounds of data collection and analysis,</p>

Citation	Key Findings	Geog. Region	Methodology
technology in construction projects. Construction Management and Economics, 34(7–8), 536–551.	(academics, practitioners, technology developers, etc.) under engaged scholarship frameworks can facilitate the adoption and optimisation of ICT in construction projects. Evolutionary Use of ICT: The findings suggest a phased, evolutionary approach to ICT adoption in construction projects, highlighting the roles of initial acceptance, integration into daily practices, and eventual institutionalisation within project management routines.		aligning findings with existing ICT adoption theories, and then refining the model based on stakeholder feedback is a core methodological feature. Engagement Mechanisms: Detailed exploration of how different engagement mechanisms affect the adoption process and how these mechanisms can be strategically managed to improve outcomes.
Rostoka, Z., Locovs, J., & Gaile-Sarkane, E., (2019). Open Innovation of New Emerging Small Economies Based on University-Construction Industry Cooperation. Journal of Open Innovation, 5(1), 10–10.	Impact on Human Resources: The study highlights a significant discrepancy between the current educational outputs of universities and the actual needs of the construction industry. It notes a lack of adequately skilled and motivated personnel, which suggests that educational programs may not be fully aligned with industry requirements. Innovation through Collaboration: The research underscores the potential for open innovation in construction processes through enhanced collaboration between the academic sector and industry. This collaboration is seen as crucial for infusing new technologies and methodologies into traditional construction practices. Role of Policy and Regulation: One of the critical findings is the influence of national policies and regulatory frameworks on the effectiveness of university-industry collaborations. The study points out that supportive policies are essential to foster these collaborations and enhance their effectiveness.	Latvia	Qualitative and Quantitative Research: The methodology combines expert interviews, focus groups, and case studies, which helps in understanding the nuanced perspectives of various stakeholders involved in university-industry collaborations. Data Triangulation: Employing triangulation, the research cross-verifies data from multiple sources to enhance the reliability of the findings. This approach helps in identifying consistent themes and discrepancies in perceptions between industry and academia.
Tener, R. K. (1996). Industry-University Partnerships for Construction Engineering	Enhanced Educational Quality: The partnership between industry and Purdue University has significantly enhanced the quality of the construction engineering education program, ensuring graduates are well-prepared for their roles in the industry.	United States	Case Study Approach: The paper utilises Purdue University's Construction Engineering and Management program as a case study to explore the dynamics and benefits of industry-university partnerships.

Citation	Key Findings	Geog. Region	Methodology
Education. Journal of Professional Issues in Engineering Education and Practice, 122(4), 156–162.	<p>Strategic Collaboration Benefits: Effective collaborations result in better alignment of educational programs with industry needs, more robust internship experiences, and higher graduate employability.</p> <p>Importance of Advisory Committees: The paper highlights the crucial role of industry advisory committees in shaping curriculum and educational strategies, ensuring they are aligned with real-world requirements and challenges.</p>		Review of Program Elements: Examination of various components of the partnership, such as curriculum design, administration, internship programs, and the roles of advisory committees.
Jang, Y., Kim, K., Leite, F., Ayer, S., & Cho, Y. K. (2021). Identifying the Perception Differences of Emerging Construction-Related Technologies between Industry and Academia to Enable High Levels of Collaboration. Journal of Construction Engineering and Management, 147(10).	<p>Perception Differences: Significant differences were identified in how industry and academia perceive the use, interest, maturity, implementation levels, application phases, and beneficial areas of various emerging technologies. Notably, academia tends to focus more on the potential and developmental aspects, while industry emphasises practical applications and implementation challenges.</p> <p>Key Technologies for Collaboration: Three technologies—3D printing, artificial intelligence (including neural networks and deep learning), and smart materials—were highlighted as having high potential for collaboration due to shared interest and varying levels of maturity and implementation between academia and industry.</p> <p>Barriers to Adoption: The study found that the main barriers to adopting new technologies in the construction industry include cost, practicability, and reliability of the technologies.</p>	United States	<p>Survey Method: An online survey was conducted among both academics and industry practitioners. The survey included questions about the adoption, interest, maturity, implementation, applications, benefits, and barriers of 17 emerging technologies.</p> <p>Statistical Analysis: The survey data were analysed using statistical methods such as chi-square tests, Fisher’s exact test, and t-tests to identify significant differences in perceptions between academia and industry.</p>
Holley, P. W., & C. Ben Farrow. (2013). Expanding Collaboration in Academia: Case Study of the	Enhanced Product Development: The collaboration between construction management and industrial design programs led to the development of over 70 construction product prototypes, highlighting the potential for significant improvements in construction productivity and safety.	United States	Collaborative Design Method: The methodology involved iterative product development cycles where students from construction management and industrial design collaborated intensively. This included identifying industry problems, conceptualising

Citation	Key Findings	Geog. Region	Methodology
Development of Construction Products. Journal of Professional Issues in Engineering Education and Practice, 139(2), 139–147.	<p>Intellectual Property Creation: The program successfully generated considerable intellectual property, including provisional and nonprovisional patents, with some products moving towards commercialisation and licensure.</p> <p>Academic and Industry Synergies: The collaboration provided substantial research opportunities for faculty and students, and deepened industry partnerships, showcasing a successful model of academia-industry synergy.</p>		<p>solutions, and creating prototypes.</p> <p>Industry Engagement: Regular interaction with industry partners to gather feedback and refine product designs was a key component, ensuring that the academic outputs were aligned with real-world industry needs.</p>
Tayeh, R., & Raja. (2021). Developing Construction Information Systems Courses Based on Collaboration between Industry and Academia. Journal of Architectural Engineering, 27(3).	<p>Skills Gap Identification: The Delphi study identified significant gaps in the expected knowledge levels of graduates from the perspectives of industry professionals versus academics, particularly in areas like BIM modelling, VDC (Virtual Design and Construction), and collaboration technologies.</p> <p>Course Development: Based on the findings, two graduate courses were specifically designed to address these gaps, focusing on information modelling, reality capture, visualisation techniques, generative design, robotics, and automation.</p> <p>Technology Integration in Education: The implementation of VR (Virtual Reality) and BIM360 platforms in these courses demonstrated significant improvements in collaborative capabilities and understanding of complex information systems among students.</p>	Florida, United States	<p>Delphi Study: A systematic Delphi study was used to assess the levels of knowledge expected of graduates by industry and academia, which involved industry professionals and academic staff.</p> <p>Curriculum Development: The feedback from the Delphi study was directly used to design the curriculum for two specialised graduate courses, ensuring that the courses are closely aligned with industry expectations.</p>
Waters, C. E., Alvine, S., & Eble-Hankins, M. (2012). Industry-Experienced Graduate Student Program: Innovative Collaboration in	<p>Program Success: The program successfully integrated experienced professionals into the PhD program, fostering significant academic and industry collaboration. This led to the enhancement of the graduate's skills and professional network.</p> <p>Mutual Benefits: The collaboration benefited all parties—students gained real-world experience and</p>	University of Nebraska –Lincoln	<p>Case Study Approach: The program's impact and processes were analysed through a case study of the first doctoral candidate, Michelle Eble-Hankins, detailing her journey through the program and her interactions with industry.</p> <p>Mixed Methods: Data collection involved direct observation of the program's implementation,</p>

Citation	Key Findings	Geog. Region	Methodology
Architectural Engineering at the University of Nebraska, Lincoln. Journal of Architectural Engineering, 18(1), 61–63.	academic knowledge, the university strengthened its industry connections, and the industry partner accessed cutting-edge research and potential future employees. Research and Professional Development: The program facilitated research on non-uniform luminance and its impact on discomfort glare, contributing new knowledge to the field and enhancing the student's academic profile.		interviews with stakeholders (students, faculty, industry partners), and analysis of the graduate's academic and professional outputs.
Chen, K., Lu, W., & Wang, J. (2020). University–industry collaboration for BIM education: Lessons learned from a case study. Industry and Higher Education, 34(6), 401-409.	Improved Learning Outcomes: The collaboration between the university and industry significantly improved students' understanding of both theoretical and practical aspects of BIM. Students reported better preparedness for the professional demands of the construction industry due to the hands-on learning experiences provided. Bridging Theory and Practice: The integration of industry expertise in academic settings helped bridge the gap between theoretical knowledge and practical application, enhancing the relevancy of the curriculum to actual industry needs. Effective Pedagogical Strategies: The study identified effective teaching strategies, including the use of real-life case studies and serious gaming, which increased student engagement and understanding of complex BIM concepts.	Hong Kong	Case Study Approach: The research utilised a case study methodology, employing non-participant observations and feedback collection from students and instructors to assess the effectiveness of the collaboration. Mixed Methods Data Collection: Data were gathered through semi-structured interviews, reflection reports from students, and direct observations of the BIM course delivery, providing a comprehensive view of the educational impact.
Mora-Valentín, E.-M., Nájera-Sánchez, J.-J., & Ortiz-de-Urbina-Criado, M. (2022). Assessment of success in university–industry cooperation literature: A bibliographic coupling	Structure of Knowledge: The study identifies a structured knowledge landscape in university-industry cooperation literature, indicating that technological, strategic, and epistemological motivations are the most frequently discussed. Evolution of Topics: The research illustrates that while some themes like technology transfer have remained central over time, others such as university performance and social capital have gained attention more recently.	Global	Bibliographic Coupling Analysis: The research uses bibliographic coupling to analyse patterns of citations among papers, which helps identify clusters of research that share common references, indicating thematic connections. Document Sampling: The study draws on a comprehensive sample of documents indexed in the Web of Science, covering articles published between 2008 and 2019.

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analysis. Science and Public Policy, 49(5), 686–698.	Interdisciplinary Insights: The analysis reveals that literature on university-industry cooperation is becoming increasingly interdisciplinary, with increasing links between technology, management, and educational research.		Data Analysis: Using the VOSviewer software for visualisation, the analysis maps out the relationships between different research clusters, providing a visual and quantitative depiction of how various themes in university-industry cooperation are interconnected.
Mitev, N., & Venters, W. (2009). Reflexive Evaluation of an Academic–Industry Research Collaboration: Can Mode 2 Management Research be Achieved? Journal of Management Studies, 46(5), 733–754.	Challenges in Mode 2 Research: The study reveals significant challenges in achieving Mode 2 research goals, which aim for transdisciplinarity and business relevance. These include conflicts among different stakeholders' goals, institutional pressures, and the inherent complexities of aligning academic research with industry needs. Barriers to Transdisciplinarity: Despite intentions, true transdisciplinarity was not achieved. There were significant differences in understanding and applying key concepts such as sustainability, driven by varying institutional agendas and disciplinary perspectives. Impact of Institutional Pressures: The research was heavily influenced by external institutional pressures, including funding requirements and industry expectations, which often led to compromises and adaptations in the research process.	United Kingdom	Reflexive Methodology: Utilising a retrospective and reflexive methodology, the study critically examines the entire process of the research collaboration, from planning through execution. This approach allowed for a deep exploration of the roles, expectations, and dynamics among the participants. Qualitative Analysis: The study involved qualitative data from project documentation, interviews, and meetings which were analysed reflexively to understand the complexities and challenges of the collaboration.
Ullah, F., & Thaheem, M. J. (2017). Concession period of public private partnership projects: industry–academia gap analysis. International Journal of Construction Management, 18(5), 418–429.	Substantial Gap in Perception: There is a significant gap in how academia and industry perceive and prioritise CSFs in PPP projects. This gap affects resource allocation and decision making processes, potentially hindering project success. Temporal Misalignment: There is an average 8–9 year temporal gap between when academic research highlights CSFs and when these factors are recognised and implemented by the industry. Diverse Focus Areas: Academia tends to focus more on theoretical and broad-based research concerning PPPs,	Global	Surveys: Surveys were conducted separately with 60 industry professionals and 56 academic experts to gauge their perspectives on these CSFs. Gap Analysis: The study quantitatively and qualitatively analyses the gaps in perception between industry and academia regarding the importance and timing of the CSFs. Statistical methods were used to analyse survey data and compare the significance of each CSF as perceived by both groups.

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	while industry prioritises practical and immediate concerns related to project execution and financial viability.		
Tang, L., Shen, Q., & Eddie W.L. Cheng. (2010). A review of studies on Public-Private Partnership projects in the construction industry. International Journal of Project Management, 28(7), 683-694.	<p>Prevalence of Empirical Research: The review identifies a strong focus on empirical research within the literature, with prevalent themes including risk management, relationship dynamics, and financial structuring of PPP projects.</p> <p>Diverse Research Themes: The literature covers a wide range of topics such as risks, financing, relationships, concession periods, and project success factors, indicating the multifaceted nature of PPP research.</p> <p>Gaps in Literature: There is a noted lack of systematic approaches in summarising and synthesising the existing findings, which the paper addresses by providing a structured review and identifying areas needing further research.</p>	UK, China, and Hong Kong	<p>Systematic Literature Review: The authors employed a systematic literature review methodology, categorising studies into empirical and non-empirical research. This helped in structuring the vast amount of literature and in drawing comprehensive insights.</p> <p>Classification of Studies: Empirical studies were grouped under themes like risks, relationships, and financing, while non-empirical studies were analysed under financing, project success factors, risks, and concession periods.</p>
Gann, D. (2001). Putting academic ideas into practice: technological progress and the absorptive capacity of construction organisations. Construction Management and Economics, 19(3), 321-330.	<p>Absorptive Capacity: The ability of construction firms to absorb and act upon academic research is influenced by their prior knowledge, ongoing technical capability, and the presence of a critical mass of professionally qualified practitioners. Firms with established internal technical support infrastructure and a track record of collaboration with universities are more likely to benefit from academic research.</p> <p>Mechanisms and Constraints: The study identifies various mechanisms through which academic ideas are transferred to the construction industry, including professional institutions, published media, and complex networks of interactions. However, traditional discipline-based activities and institutional constraints often hinder the development and absorption of new ideas.</p> <p>Role of Professional Institutions: Professional institutions play a dual role. They act as repositories of</p>	United Kingdom	<p>Think Piece and Workshop: The paper originates from a 'think piece' commissioned by the UK Construction Research and Innovation Strategy Panel (CRISP). It incorporates feedback and ideas generated at a workshop involving leading industrial and academic participants.</p> <p>Empirical Evidence: The study draws on employment data and research and development data to assess the absorptive capacity of construction firms. It examines the extent to which firms employ professionally qualified staff and invest in formal R&D activities.</p>

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	<p>knowledge, facilitating the dissemination of new ideas. However, they can also constrain development by adhering to outdated notions of narrowly defined disciplines.</p> <p>Government and Collaborative Research: Government-sponsored collaborative research projects can catalyse the transfer of academic ideas to industry. Such projects bring together academic researchers and industrial practitioners, fostering a collaborative environment for innovation.</p>		
<p>Lucko, G., & Kaminsky, J. A. (2016). Construction Engineering Conference and Workshop 2014: Setting an Industry–Academic Collaborative Research Agenda. Journal of Construction Engineering and Management, 142(4).</p>	<p>Collaborative Outcomes: The conference and workshop successfully initiated new collaborations among 49% of participants, highlighting the potential for such events to foster meaningful partnerships between academia and industry.</p> <p>Attributes of Basic Construction Engineering Research: The workshop identified four fundamental attributes essential to construction engineering research: advancing knowledge, improving construction delivery, serving industry, and pursuing sustainability.</p> <p>Research Agenda: A comprehensive research agenda was developed, focusing on global systems and sustainability, technology and management, and research methods. This agenda aims to guide future research efforts and collaboration in the field.</p>	<p>United States</p>	<p>Conference and Workshop Structure: The methodology involved organising a dedicated research conference followed by a workshop sponsored by the National Science Foundation (NSF). The workshop included plenary sessions, breakout groups, and collaborative brainstorming to identify research needs and develop proposals.</p> <p>Qualitative Data Collection: Data was collected through individual questionnaires, group brainstorming sessions, and feedback from participants. This qualitative data was analysed using NVivo software to identify themes and research needs.</p> <p>Iterative Feedback: The workshop utilised iterative feedback from participants to refine the research agenda, ensuring that it was comprehensive and aligned with both academic and industry needs.</p>
<p>Aouad, G., Ozorhon, B. and Abbott, C. (2010). Facilitating innovation in construction:</p>	<p>Innovation Drivers and Barriers: The paper identifies key drivers of innovation, such as environmental sustainability, labour and skills shortages, and global competition. Barriers include the adversarial nature of construction contracts, fragmented supply chains, and a</p>	<p>United Kingdom</p>	<p>Interviews and Workshops: The authors conducted interviews and workshops with industry and academic stakeholders to gather qualitative data on the current state of innovation in construction and the</p>

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Directions and implications for research and policy. Construction Innovation, Vol. 10 No. 4, pp. 374-394.	<p>conservative approach to adopting new methods and technologies.</p> <p>Role of Professional Institutions: Professional institutions play a crucial role in facilitating innovation by acting as repositories of knowledge and fostering collaboration between industry and academia. However, they can also constrain innovation by adhering to outdated practices.</p> <p>Innovation Platforms: The study proposes the creation of innovation platforms that link higher education institutions with the construction industry to promote innovation. These platforms should engage all stakeholders, address diverse needs, and provide solutions and new ideas while stimulating demand and developing capability.</p>		<p>effectiveness of different approaches to fostering innovation.</p>
Hadiwattege, C., Senaratne, S., Sandanayake, Y. and Fernando, N.G. (2018). Academic research in emerging knowledge-based economies: The case of Sri Lankan construction industry. Built Environment Project and Asset Management, Vol. 8 No. 4, 415-428.	<p>Ineffectiveness of Academic Research: The study found that academic research in Sri Lanka has not effectively contributed to the innovative development of construction management. The primary reasons include the lack of industry-focused knowledge dissemination strategies and weak academic-industry relationships that are often non-research-based.</p> <p>Knowledge Utilisation Gaps: There is a significant gap between the knowledge produced by academia and its utilisation by industry practitioners. This gap leads to a lack of research-informed decision making in the industry, resulting in fewer innovations.</p> <p>Dissemination and Utilisation Issues: Both knowledge dissemination efforts by academics and knowledge utilisation by industry practitioners are found to be inadequate. While academics reach the initial stages of knowledge dissemination (delivery and cognition), they struggle to achieve higher stages like mind-set shift, initiation, adoption, implementation, and impact.</p>	Sri Lanka	<p>Mixed-Methods Approach: The research employs a mixed-methods approach informed by a pragmatist philosophical stance. This approach combines quantitative surveys and qualitative interviews to gather comprehensive data from both academic and industry perspectives.</p> <p>Survey and Interview Phases: Phase I involved surveys to obtain perspectives from construction management academics and industry practitioners, followed by Phase II, which included semi-structured interviews with high-profile academics and representatives from innovative construction organisations.</p> <p>Data Analysis Tools: Quantitative data from surveys were analysed using SPSS software to identify median and quadrant values, while qualitative data from interviews were analysed</p>

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	Similarly, industry practitioners often fail to progress beyond awareness and acceptance stages of knowledge utilisation.		using NVivo software to create mind-maps and identify key themes.
Hadiwattege, C., Senaratne, S., Sandanayake, Y. G., & Fernando, N. (2020). Merging Academic Research and Industry Requirements for Innovative Construction Management Practices in Sri Lanka: A Study on Critical Success Factors. International Journal of Construction Education and Research, 18(1), 32–48.	<p>Critical Success Factors (CSFs) for Innovation: The study identified several CSFs necessary for fostering research-driven innovations in construction management practices. These factors are categorised into three main stages: research initiation, execution, and dissemination.</p> <p>Challenges in Knowledge Dissemination: The research highlights significant challenges in disseminating academic knowledge to the construction industry, emphasising the need for effective strategies to bridge the gap between theoretical research and practical application.</p> <p>Role of Collaborative Efforts: Successful innovation in construction management requires collaborative efforts between academia, industry, and government. The study proposes a model (MRI) to facilitate these collaborations and ensure the effective utilisation of academic research in the industry.</p>	Sri Lanka	<p>Mixed-Methods Approach: The study employs a mixed-methods approach, integrating quantitative surveys and qualitative interviews. This approach ensures a comprehensive understanding of the perspectives of both academia and industry.</p> <p>Literature Review: A thorough literature review was conducted to identify potential success factors for merging academic research with industry requirements.</p> <p>Surveys: Questionnaires were distributed to construction management academics and industry practitioners to gather data on their perceptions of CSFs.</p> <p>Interviews and Case Studies: Semi-structured interviews with academic experts and case studies of leading construction organisations provided in-depth qualitative insights.</p> <p>External Validation: The proposed model was validated through expert interviews to ensure its applicability and relevance.</p>
Zabidin, N. S., Belayutham, S., & Che Ibrahim, C. K. I. (2024). The knowledge, attitude and practices (KAP) of Industry 4.0 between construction practitioners and academicians in	<p>Knowledge Gap: Academicians have a better knowledge profile of Industry 4.0 compared to industry practitioners. This reflects the nature of academic work which constantly seeks new knowledge.</p> <p>Attitude Similarities: Both academics and industry practitioners exhibit similar attitudes towards the importance of Industry 4.0, recognising its potential to improve performance and efficiency in the construction industry.</p> <p>Practice Disparities: While a majority of both groups</p>	Malaysia	<p>Mixed-Methods Approach: The research combines structured questionnaires and semi-structured interviews to gather comprehensive data.</p> <p>KAP Survey: The structured survey includes questions on knowledge, attitude, and practices related to Industry 4.0. The survey was distributed both online and face-to-face, with 74 respondents (42 industry practitioners and 32 academicians).</p>

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Malaysia: A comparative study. Construction Innovation, 24(5), 1185–1204.	<p>have begun implementing Industry 4.0 tools and concepts, the extent and manner of implementation vary. Industry practitioners tend to implement these technologies more practically, whereas academics focus on theoretical applications.</p> <p>Knowledge Equilibrium Framework: The study suggests the establishment of an Industry-Academic (I-A) Knowledge Equilibrium Framework to leverage the knowledge profile between both parties and facilitate better collaboration.</p>		<p>Semi-Structured Interviews: Follow-up interviews were conducted with select respondents to explore gaps identified in the survey and propose solutions.</p>
Fayek, A. R., & Golabchi, A. (2022). Framework for identification of performance metrics for research and development collaborations: Construction Innovation Centre. Built Environment Project and Asset Management, 12(5), 837–852.	<p>Development of a Research Roadmap: The study presents a research roadmap that identifies the top research areas and methods relevant to the construction industry. This roadmap serves as a guide for future research initiatives and priorities.</p> <p>Identification of In-Demand Services: The research highlights the most in-demand services for industry partners, including research services, practical approaches, and training and outreach opportunities. This ensures that the Construction Innovation Centre (CIC) aligns its offerings with industry needs.</p> <p>Services Offered by CIC:</p> <p>Research Services: Include a continually updated research roadmap, leveraged funding for fundamental and contract research, and laboratory facilities for demonstrating solutions.</p> <p>Practical Approaches: Include industry forums, input into research projects, and rights to first disclosure/use of research results.</p> <p>Training and Outreach Opportunities: Include professional development workshops, certificate programs, student internships, and sponsored research projects for students.</p> <p>Performance Metrics Framework: The study proposes a</p>	Canada	<p>Surveys and Interviews: The study used surveys and interviews with researchers and industry practitioners to gather data on the most important research areas, services, and performance metrics.</p> <p>Survey: The survey included questions about research priorities, services, and performance metrics. It was distributed to a diverse group of stakeholders, including academics, industry professionals, and government representatives.</p> <p>Interviews: Follow-up interviews with select respondents provided deeper insights into the survey findings and helped refine the proposed framework.</p>

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	<p>comprehensive framework for evaluating the performance of research and development (R&D) collaborations. This framework includes metrics for evaluating proposed projects, completed projects, and the research centre itself. Performance Metrics:</p> <p>For Proposed Projects: Metrics include alignment with top-priority research areas, potential for implementation, reach of benefits, interest and degree of collaboration, and scientific contribution.</p> <p>For Completed Projects: Metrics include industry uptake, academic performance, applicability to other organisations, and the multidisciplinary nature of the research.</p> <p>For the Research Centre: Metrics include industry engagement, adoption rate, academic performance, national and international recognition, and outreach activities.</p>		
<p>Sexton, M., & Lu, S. (2009). The challenges of creating actionable knowledge: an action research perspective. Construction Management and Economics, 27(7), 683–694.</p>	<p>Actionable Knowledge Production: The study identifies that creating actionable knowledge, which bridges the gap between academia and industry, requires addressing three key design principles: change focus, collaboration capabilities, and a systematic process.</p> <p>Change Focus: The study emphasises the importance of having clear and explicit objectives for the action research intervention. These objectives should be communicated effectively to all organisational members to ensure buy-in and active participation.</p> <p>Collaboration Capabilities: Successful collaboration requires both parties to bring their unique expertise and perspectives to the table. In the case study, the architectural firm provided contextual knowledge while the academic researchers offered expertise in quality management systems.</p>	<p>United Kingdom</p>	<p>Action Research: The research employs an action research methodology, which is characterised by its iterative cycles of planning, acting, observing, and reflecting. This approach facilitates continuous learning and adaptation.</p> <p>Diagnosis Phase: Initial interviews and exploratory activities to identify key issues and areas for improvement.</p> <p>Action Planning: Collaborative development of an action plan with specific objectives, tasks, and deliverables.</p> <p>Action Taking: Implementation of the planned actions within the firm, involving regular meetings and feedback sessions.</p> <p>Action Evaluation: Assessment of the outcomes of the implemented actions and</p>

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	<p>Systematic Process: The action research process needs to be systematic and structured, following a clear sequence of steps. This ensures that the research is rigorous, and the knowledge produced is actionable and relevant to the firm's needs.</p> <p>Importance of Collaboration: Effective collaboration between academics and practitioners is essential for producing knowledge that is both rigorous and relevant. This collaboration needs to be deeply embedded in the research process to ensure mutual benefits.</p> <p>Action Research Utility: Action research is highlighted as a suitable methodology for generating actionable knowledge. It integrates academic rigor with practical relevance by involving participants from both academia and industry throughout the research process.</p>		<p>reflection on the learning process.</p> <p>Specifying Learning: Documenting the knowledge gained and lessons learned to inform future practice and research.</p>
<p>Kulatunga, U., Amaratunga, D., & Haigh, R. (2009). Critical success factors of construction research and development. Construction Management and Economics, 27(9), 891–900.</p>	<p>Stakeholder Satisfaction: The study highlights the importance of stakeholder satisfaction throughout the lifecycle of construction R&D projects, from initiation to launch. Ensuring that the needs of stakeholders, such as industrial partners and funding bodies, are met is crucial for the success of these projects.</p> <p>Principal Investigator's Role: The commitment and leadership of the principal investigator are essential in driving the project forward, ensuring adequate resources, and maintaining team motivation.</p> <p>Clear Objectives and Feasibility Studies: Establishing clear research objectives and conducting thorough feasibility studies are critical at the initiation phase to lay a solid foundation for the research project.</p> <p>Skilled and Committed Team: The success of R&D projects heavily relies on having a skilled and committed team. The study emphasises the importance of team members' skills, motivation, and collaboration</p>	<p>United Kingdom</p>	<p>Semi-Structured Interviews and Questionnaire Survey: The study employed a combination of semi-structured interviews and a questionnaire survey to gather data from principal investigators, researchers, and industrial partners involved in collaborative construction R&D projects.</p> <p>NVivo Software: NVivo software was used to analyse the interview transcripts and identify the main concepts regarding the success factors.</p> <p>Filtering and Analysis: The data from the questionnaire were subjected to two filtering stages to derive the critical success factors. First, factors with a mean value of less than 4 were excluded. Second, the remaining factors were analysed using the Wilcoxon signed-rank</p>

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	<p>throughout the project.</p> <p>Effective Project Management: Continuous monitoring, effective communication, proper resource management, and having a well-defined operational plan are vital for the successful management of R&D projects.</p>		<p>test to identify those with significant differences in importance.</p>
<p>Patrick X.W. Zou, Riza Yosia Sunindijo, & Andrew R.J. Dainty. (2014). A mixed methods research design for bridging the gap between research and practice in construction safety. Safety Science, 70, 316–326.</p>	<p>Dominance of Quantitative Research: The study reveals that nearly half of the reviewed construction safety research articles (43.2%) use quantitative methods, while qualitative methods are used in about a quarter (23.9%) of the studies. Mixed methods are rarely employed (9.1%), suggesting a gap in integrating quantitative and qualitative approaches.</p> <p>Importance of Mixed Methods: The authors argue for a greater use of mixed methods research to bridge the gap between theory and practice. Mixed methods can enhance the co-production of safety theories and knowledge by enabling collaboration between university researchers and industry practitioners.</p> <p>Proposed Framework: The study proposes a framework that integrates different research methodologies to create actionable knowledge. This framework encourages iterative collaboration between researchers and practitioners, emphasising the need for continuous feedback and adaptation to improve safety practices in the construction industry.</p> <p>Challenges and Recommendations: The study acknowledges the challenges of implementing mixed methods research, such as gaining industry participation and managing the complexity of the research design. It recommends focusing on topics that are relevant and valuable to industry partners to secure their engagement.</p>	<p>Australia and the United Kingdom</p>	<p>Literature Review: The study involves a comprehensive review of 88 construction safety research articles published in five highly ranked international journals and one international conference proceedings in 2009. The articles are classified based on their research methods to understand the prevalent approaches in construction safety research.</p> <p>Mixed Methods Framework: The proposed framework incorporates both quantitative and qualitative research methods. It emphasises iterative cycles of planning, acting, observing, and reflecting, which are fundamental to action research.</p>
<p>Ofori, G. (1993). Research on</p>	<p>Historical Context and Current Challenges: The study provides a historical overview of construction industry</p>	<p>Africa, Asia, and</p>	<p>Historical Analysis: The study includes a historical analysis of the development of</p>

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construction industry development at the crossroads. Construction Management and Economics, 11(3), 175–185.	<p>development in developing countries, highlighting the initial progress and subsequent stagnation. Early recommendations were often not implemented or lacked practicality, leading to minimal advancements.</p> <p>Criticism of Past Approaches: The author critiques previous research and recommendations for their generic nature and failure to account for country-specific conditions. The paper emphasises the need for tailored strategies that consider the unique economic, social, and political contexts of each country.</p> <p>Proposal for Global Coordination: The study suggests forming a global body dedicated to promoting, coordinating, and disseminating research on construction industry development. This body would help consolidate efforts and provide a focused approach to addressing the industry's challenges in developing countries.</p>	Latin America.	<p>construction industries in developing countries, examining the evolution of policies and their impacts over time.</p> <p>Critique and Synthesis: The paper critiques past approaches, synthesising findings from various sources to propose a new direction for research and development in the construction industry.</p>
Chen, G., Zhang, G., Xie, Y. M., & Jin, X. H. (2012). Overview of alliancing research and practice in the construction industry. Architectural Engineering and Design Management, 8(2), 103–119.	<p>Historical Context: The concept of alliancing originated in the North Sea offshore industry and has since been adopted in various sectors of the construction industry, particularly in Australia and the UK. Early applications focused on addressing cost pressures and achieving high-quality outcomes under tight time constraints.</p> <p>Advantages of Alliancing: Alliancing in the construction industry can address long-standing issues such as cost overruns, delays, adversarial relationships, and disputes. It offers benefits like cost and time efficiency, quality improvements, and enhanced project performance through interorganisational cooperation.</p> <p>Alliancing is characterised by principles such as mutual trust, shared risk/reward mechanisms, open communication, and collective decision making. These principles differentiate alliancing from other collaborative approaches like partnering.</p>	Global, Australia and the UK	<p>Literature Review: The study conducts a comprehensive literature review of 79 articles and research reports on alliancing in the construction industry. These sources were selected through a multi-step search process in major databases and from various industry reports.</p> <p>Five-Stage Knowledge Progression Framework: The literature review is organised and synthesised using a five-stage knowledge progression framework, which includes development and advocacy, technical refinement, situating the practice in its organisational context, linkage to other processes and tools, and institutionalisation and diffusion.</p>

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	<p>Challenges and Limitations: Despite its benefits, alliancing faces challenges, including the need for strong commitment from all parties, potentially high transaction costs, and difficulties in establishing trust and collaborative environments. The study also identifies a lack of economic theory application in evaluating alliancing's efficiency.</p> <p>Research Gaps: The paper highlights gaps in the current research, particularly in the areas of cost management practices, control mechanisms, and the efficiency of alliancing. There is also a need for more empirical studies and a theoretical foundation for alliancing practices.</p>		
<p>Ahmad, T., Aibinu, A. A., & Ahmed, D. (2024). Construction Engineering and Management: Review of Research from Australia-Based Academics. Buildings, 14(7), 1913–1913.</p>	<p>Research Focus Areas: Australia-based CEM research aligns with global trends but places higher emphasis on safety, accident prevention, economics, energy use and efficiency, and stakeholder management. It has less focus on building materials, material management, infrastructure, information management, and BIM compared to global research.</p> <p>Collaboration Trends: High collaboration rates among Australian institutions and with international counterparts, particularly from China and Hong Kong. The top collaborating Australian universities include Curtin University, UNSW, RMIT University, Queensland University of Technology, Deakin University, and Western Sydney University.</p> <p>Publication Volume and Impact: Australia ranks fourth globally in CEM research publication volume. However, the study highlights the significant contributions of a few key academics to this volume, following the Pareto principle.</p> <p>Temporal Trends: There has been a significant increase in the volume of CEM publications from Australia since</p>	Australia	<p>Scientometric and Critical Review Techniques: The study uses a combination of scientometric analysis and critical review techniques to map the landscape of CEM research in Australia.</p> <p>Data Collection: The study reviews 4318 publications from 158 Australia-based academics. These publications were identified through a hybrid search strategy involving Scopus and Web of Science databases.</p> <p>Science Mapping: The analysis includes keyword co-occurrence and co-authorship network mapping using VOSviewer, and data refinement with OpenRefine.</p> <p>Temporal and Thematic Analysis: A detailed temporal analysis was conducted to identify trends in research topics and publication volumes over time.</p>

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	<p>2013, with recent research focusing more on sustainability, green buildings, life cycle assessment, BIM, and energy efficiency.</p> <p>Early research (1980s-1990s): Focused on project scheduling, procurement, cost, quality, conflicts, and structural aspects.</p> <p>Recent research (2000s onwards): Shifted towards risk management, BIM, safety, public infrastructure, and sustainable practices.</p> <p>Recent publication peaks: Many research topics saw increased publication volumes around 2018-2020, possibly due to the impact of the COVID-19 pandemic on research activities.</p> <p>Keyword and Theme Analysis: Key research themes include project management, risk management, sustainable development, safety, and decision making.</p> <p>Emerging topics: Sustainability, green buildings, life cycle assessment, BIM, energy efficiency, architectural design, and construction waste.</p>		
<p>Rigby, E. T., McCoy, A. P., & Garvin, M. J. (2012). <i>Toward Aligning Academic and Industry Understanding of Innovation in the Construction Industry</i>. <i>International Journal of Construction Education and Research</i>, 8(4), 243–259.</p>	<p>Agreement on Definitions: There is some agreement between academia and industry on definitions for project delivery and innovation. However, there is a need for improved mutual understanding of innovative project delivery and the barriers to and opportunities for innovation.</p> <p>Barriers to Innovation: Identified barriers include inefficiencies, codes and budgets, lack of transparency, lack of trust, too much conflict, defensive behaviour, and finger-pointing.</p> <p>Drivers for Innovation: Drivers include the desire to improve communication and collaboration, increased publicity on alternative/better solutions, and the need for better quality products.</p> <p>Innovative Systems and Technologies: Building</p>	<p>United States</p>	<p>Utilised a mixed-methods approach, combining a small-scale survey with in-depth interviews. The survey was administered to 35 members of the BuildingSmart Alliance, and interviews were conducted with six contractors to gather detailed case study perspectives. The survey included questions on demographics, contract types, delivery methods, stakeholder perceptions, and definitions of innovation and project delivery. The interviews aimed to delve deeper into the barriers and drivers of innovation in the construction industry.</p>

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	<p>Information Modelling (BIM) and integrated project delivery methods are seen as potential avenues for fostering innovation.</p> <p>Collaboration and Lean Construction: Increased collaboration and lean approaches are identified as innovative strategies for the construction process.</p> <p>Stakeholder Roles: Owners, architects, and general contractors are seen as key stakeholders driving innovation, whereas specialty contractors are not considered as critical.</p> <p>Disconnect Between Academia and Industry: There is a semantic and circumstantial disconnect between academic research and industry practice, necessitating better communication and collaboration.</p>		
<p>Adepoju, O. O., & Aigbavboa, C. O. (2020). Assessing knowledge and skills gap for construction 4.0 in a developing economy. Journal of Public Affairs, 21(3).</p>	<p>Moderate Knowledge: Professionals exhibit a moderate level of knowledge about Construction 4.0 technologies, such as social media, mobile computing, automation, IoT, BIM, 3D printing, big data, and human-computer interaction.</p> <p>Low Training Levels: There is a low level of training among professionals concerning Construction 4.0 technologies, indicating a lack of preparedness for adopting these innovations.</p> <p>High Skills Gap: The most pronounced skills gaps are in human-machine communication, data analytics, and cybersecurity, followed by programming/coding. Professionals show high competency in soft skills like communication, teamwork, problem-solving, critical thinking, and decision making, but these are not sufficient to meet the technical demands of Construction 4.0.</p>	Nigeria	<p>Cross-sectional survey design with a quantitative approach. A structured questionnaire was administered to 136 construction professionals selected through a convenience sampling technique. The questionnaire covered four sections: background information, awareness of Construction 4.0, knowledge of Construction 4.0 technologies, and skills assessment. Data were analysed using descriptive statistics (mean scores, frequencies, percentages) and inferential statistics (Pearson chi-square, paired t-test) with SPSS V23.</p>
<p>Oswald, D., & Dainty, A. (2020). Ethnographic</p>	<p>Diverse Approaches: Ethnographic research in construction has expanded beyond traditional long-term observational studies to include a variety of methods</p>	UK, Mexico	<p>The review employed a systematic approach to identify and analyse 57 relevant ethnographic studies published since 2011.</p>

Citation	Key Findings	Geog. Region	Methodology
Research in the Construction Industry: A Critical Review. Journal of Construction Engineering and Management, 146(10).	<p>such as autoethnography, quasi-ethnography, ethnographic-action research, and ethnographic interviewing. This diversity has enabled researchers to capture rich, contextual insights into the industry's practices and challenges.</p> <p>Methodological Rigor: The review identifies inconsistencies in the evaluation of methodological rigor across ethnographic studies. While some studies demonstrate robust reflexivity and transparency regarding the researcher's influence, others lack this critical component, potentially undermining their validity.</p> <p>Practical Interventions: Ethnographic research has increasingly focused on practical interventions aimed at improving industry practices. This includes studies on technology implementation, safety practices, and cultural shifts within organisations.</p> <p>Researcher Safety and Ethics: The review emphasises the importance of considering the safety and ethical implications of ethnographic research in construction, particularly given the industry's physically and mentally challenging environment.</p>		<p>The methodology involved:</p> <p>Literature Search: The authors conducted keyword searches in high-quality construction journals and multidisciplinary databases to identify relevant studies.</p> <p>Classification of Studies: The identified studies were categorised into three main types: longer-term ethnographic work, shorter-term applied ethnographic approaches, and alternate forms of ethnographic research.</p> <p>Critical Analysis: The authors critically analysed the methodological rigor, reflexivity, and contributions of each study, considering the varied approaches and contexts in which they were conducted.</p>
Harty, C., & Leiringer, R. (2017). The futures of construction management research. Construction Management and Economics, 35(7), 392–403.	<p>Expansion and Diversification: Construction Management Research (CMR) has evolved significantly from its initial focus on engineering and applied sciences to incorporate broader academic debates in business, management, economics, and social sciences. This has positioned CMR as a distinct academic field.</p> <p>Institutional Dynamics: The paper identifies key institutional dynamics shaping CMR, including the increasing pressure on academics to publish in high-impact journals, the need for research funding, and the influence of university rankings. These dynamics are creating tensions between academic rigor and practical relevance.</p>	<p>United Kingdom and the European Union</p>	<p>A qualitative approach, using scenario development based on principles from the intuitive logics school of scenario planning. This method allows for the exploration of multiple potential futures for CMR by examining current trends and pressures within the field. The authors also draw on existing literature and their previous research to inform their analysis.</p>

Citation	Key Findings	Geog. Region	Methodology
	<p>Future Scenarios: The authors propose four potential future scenarios for CMR: convergence, retrenchment, disappearance, and hybridisation. Each scenario reflects different possible responses to the current institutional pressures and external demands faced by the field.</p> <p>Impact on Research and Practice: The emphasis on publishing in high-impact journals and securing research funding may drive CMR to align more closely with mainstream academic fields, potentially at the expense of its unique focus on construction-specific issues. This could lead to a greater emphasis on theoretical contributions over practical applications.</p>		
<p>Gambatese, J. A., & Hallowell, M. (2011). Factors that influence the development and diffusion of technical innovations in the construction industry. Construction Management and Economics, 29(5), 507–517.</p>	<p>Factors Influencing Innovation: The study identifies several critical factors influencing the development and diffusion of technical innovations in the construction industry. Key motivators include cost savings, competitive advantage, improved quality, and increased productivity. Major barriers to innovation include clients' fear of change, lack of recognition of the value of innovations, and lack of communication between innovation-generating organisations (IGOs) and clients.</p> <p>Resource Requirements: Successful development, implementation, and diffusion of an innovative product required, on average, 38 months, 4700 worker-hours, and \$836,000. These substantial investments highlight the resource-intensive nature of innovation in construction.</p> <p>Role of IGOs and IAOs: Innovation-generating organisations (IGOs) play a crucial role in initiating and developing new products, technologies, and processes, while innovation-adopting organisations (IAOs) are key to the diffusion of these innovations across the industry.</p> <p>Enablers of Innovation: Effective upper management,</p>	<p>United States</p>	<p>Survey and Data Collection: The study utilised a structured survey distributed to 189 developers of innovative products, technologies, and management strategies in the construction industry, with a total of 34 responses received (18% response rate). The survey included questions on the demographics of respondents, the nature of the innovations, and factors influencing their development and diffusion.</p> <p>Statistical Analysis: Data from the surveys were statistically analysed to identify common themes and quantify the relative impacts of various factors on the innovation process. Factor analysis and regression analysis were performed to evaluate the relationships between different impacting factors and innovation outcomes.</p>

Citation	Key Findings	Geog. Region	Methodology
	owner/client support, organisational culture, presence of an innovation champion, and communication within the firm were identified as significant enablers of innovation. Marketing and Diffusion: The extent of marketing efforts and the level of communication within firms significantly impact the diffusion of innovations. Firms with better marketing and communication practices see higher rates of innovation adoption.		
Ofori, G. (2000). Globalisation and construction industry development: research opportunities. Construction Management and Economics, 18(3), 257–262.	<p>Impact of Globalisation: Globalisation has led to significant changes in the construction industry in developing countries, particularly in Asia, including increased private sector participation, vertical integration, and heightened foreign participation.</p> <p>Technology Transfer: Technology transfer is crucial for the development of construction industries in developing countries, with mixed results observed in joint ventures and other forms of technology transfer.</p> <p>Corporate Development: Emphasising the importance of corporate development within the construction industry, there is a need for strategic alliances and improved management practices to compete globally.</p> <p>Institutional Reforms: Institutional, legal, and economic reforms are necessary to facilitate the integration of local construction firms into the global market.</p>	China, India, Indonesia, Laos, Malaysia, Thailand, and Vietnam	A literature review methodology is employed, analysing existing studies and reports on globalisation and the construction industry. Works of various authors and institutions are reviewed to draw conclusions about the current state and future opportunities for construction industry development.
Ofori, G. (1993). Research on construction industry development at the crossroads. Construction Management and Economics, 11(3), 175–185.	<p>Role in National Economy: Construction plays a critical role in national economies, contributing to capital formation and overall socio-economic development.</p> <p>Challenges and Gaps: Despite various policies and programs, practical progress in construction industry development remains elusive. The paper highlights the persistent gaps between research and practical implementation.</p> <p>Need for Coordination: There is a significant need for the consolidation, promotion, and coordination of</p>	Developing Countries	Utilises a literature review methodology, drawing on existing studies, reports, and data analyses to discuss the state of construction industry development. It critiques past approaches, highlights gaps in research, and proposes new directions for future studies.

Citation	Key Findings	Geog. Region	Methodology
	<p>research on a global basis to advance the field and improve practical applications.</p> <p>Local and Global Factors: The construction industry is influenced by both local conditions and global trends. Issues such as the environment, technology development, and productivity enhancement are relevant globally.</p> <p>Economic Context: The performance of the construction industry is closely linked to the broader economic context of a country. Structural economic problems in developing countries necessitate specific strategies for construction industry development.</p>		
<p>Kulatunga, U., Amaratunga, D., & Haigh, R. (2007). Performance measurement in the construction research and development. International Journal of Productivity and Performance Management, 56(8), 673–688.</p>	<p>Performance Measurement: The implementation of performance measurement (PM) within construction R&D is critical for enhancing its efficiency and effectiveness. It helps in identifying requirements, defining clear objectives, evaluating success, providing information to funders, improving communication, and offering feedback for future improvements.</p> <p>Resource Utilisation: The lack of proper evaluation criteria and reporting mechanisms in construction R&D leads to insufficient resource utilisation and reduced investment from funders.</p> <p>Collaborative Research: Collaborative research between universities and construction organisations, supported by funding agencies, is identified as a more productive approach to addressing practical industry problems and enhancing theoretical knowledge.</p>	<p>UK, France, Japan, Scandinavia.</p>	<p>Employs a comprehensive literature review to examine the role, main contributors, and issues within construction R&D. It defines PM, discusses its importance, and explores how implementing PM can address the identified issues in construction R&D.</p>
<p>Ghansah, F. A., & Lu, W. (2023). Responses to the COVID-19 pandemic in the construction industry: a literature review of</p>	<p>Impact on Operations: The COVID-19 pandemic significantly disrupted construction operations globally. Key negative impacts included project delays, cost overruns, and severe workforce shortages due to lockdowns and social distancing measures. However, there were also positive impacts such as accelerated</p>	<p>USA, China, UK, Malaysia, Australia,</p>	<p>Utilises a six-step thematic analysis methodology, examining 159 empirical peer-reviewed research articles from 2020 to 2022. The steps include:</p> <p>Data Collection: Publications were sourced</p>

Citation	Key Findings	Geog. Region	Methodology
<p>academic research. Construction Management and Economics, 41(9), 781–803.</p>	<p>innovation and adoption of digital technologies, which improved communication, monitoring, and project management. This led to the widespread use of virtual meetings, remote monitoring tools, and Building Information Modelling (BIM) to maintain project progress despite restrictions.</p> <p>Health and Safety: The pandemic underscored the importance of health and safety in the construction industry. Enhanced safety protocols were implemented, including mandatory use of personal protective equipment (PPE), regular health screenings, and stringent hygiene practices. These measures not only aimed to protect workers from COVID-19 but also improved overall site safety standards.</p> <p>Challenges and Opportunities: While the pandemic posed significant challenges such as disruptions in supply chains, increased project costs, and compliance with evolving health regulations, it also created opportunities for the industry. There was a notable shift towards modular and prefabricated construction methods, which require fewer onsite workers and can be completed faster. Additionally, the industry saw an increase in stakeholder engagement and collaboration, fostering a more resilient and adaptive approach to project management.</p>	<p>Nigeria, Egypt</p>	<p>from Scopus and Web of Science using keywords related to COVID-19 and construction.</p> <p>Initial Review: Screening and preliminary review of the collected articles to ensure relevance and quality.</p> <p>Coding: Identifying key themes, topics, and patterns within the literature.</p> <p>Theme Development: Generating themes from coded data to represent the main areas of research.</p> <p>Review and Refinement: Ensuring the themes accurately reflect the data and are meaningful.</p> <p>Report Production: Compiling the findings into a comprehensive report that discusses the major themes and their implications.</p>
<p>Fabbe-Costes, N. (2018). Logistics knowledge creation in joint industry-academia research projects: the importance of dialogue and co-construction.</p>	<p>Importance of Co-construction: The research underscores the critical role of co-construction in logistics knowledge creation within joint industry-academia projects. Co-construction involves collaborative efforts from both industry and academic partners to develop research objectives, methodologies, and outcomes. This approach ensures that the research is relevant and useful to both parties. The study highlights that projects where objectives and processes</p>	<p>Europe</p>	<p>Uses a qualitative research design based on multiple case studies. It involves:</p> <p>Case Selection: Eight research projects were selected based on their relevance to logistics and supply chain management (SCM) and their potential to provide rich data on industry-academia interactions.</p> <p>Data Collection: Comprehensive data collection from project archives, including</p>

Citation	Key Findings	Geog. Region	Methodology
Knowledge Management Research & Practice, 16(4), 464–476.	<p>were co-constructed from the beginning tended to produce more valuable and actionable knowledge.</p> <p>Role of Dialogue: Continuous and effective dialogue between industry and academia is identified as a cornerstone for successful research projects. Dialogue facilitates mutual understanding, helps clarify research objectives, and aligns expectations. It also aids in resolving conflicts and adapting research methodologies to meet both academic rigor and practical applicability. The research shows that projects with regular and open communication were more likely to overcome challenges and produce meaningful results.</p> <p>Challenges and Success Factors: The study identifies several challenges in joint industry-academia research projects, including differing expectations, confidentiality concerns, and time constraints. Success factors include:</p> <p>Clear Objectives: Projects with well-defined and mutually agreed-upon objectives were more successful.</p> <p>Robust Methodologies: A carefully designed methodology that can adapt to emerging needs and insights is crucial.</p> <p>Top Management Involvement: Active involvement of top managers from the industry partners ensures that the project remains aligned with strategic goals.</p> <p>Trust and Previous Experience: Previous collaborative experiences and established trust between partners significantly enhanced the project's effectiveness.</p>		<p>emails, contracts, meeting minutes, research diaries, and reports. This archival data provides a detailed account of the project processes and interactions.</p> <p>Single Case Analysis: Each project is analysed retrospectively using reflexive thinking. This involves reflecting on the project's processes, decisions, and outcomes to understand the dynamics of industry-academia interactions and their impact on logistics knowledge creation.</p> <p>Cross-case Analysis: The results of the single case analyses are compared to identify common themes, differences, and insights. This comparative analysis helps to generalise findings and develop broader conclusions.</p> <p>Structuring Results: The combined insights from single and cross-case analyses are structured into a coherent framework that outlines the key components and interactions in joint research projects.</p>
Bennett, J. (1993). Japan's Building Industry: The New Model. Construction Management and Economics, 11(1), 3–17.	<p>Efficiency Through Standardisation: The major Japanese construction companies, known as the big five, have perfected the art of operational efficiency by applying highly standardised processes to construction site work. This involves meticulous planning and detailed execution that ensures projects adhere strictly to schedules and quality benchmarks.</p>	Japan	<p>The study is qualitative, involving interviews with senior managers and visits to over 100 construction sites. It examines the relationship between research institutes and mainstream project work, exploring the impact of innovations on standardised operations.</p>

Citation	Key Findings	Geog. Region	Methodology
	<p>Balancing Innovation with Efficiency: Despite their reliance on standardisation, these firms invest heavily in research and development. This dynamic creates a unique ecosystem where cutting-edge innovations coexist with standardised production techniques. The study illustrates how these firms manage the tension between maintaining efficient, predictable workflows and integrating new, often disruptive, technologies.</p> <p>Adaptive Strategies to External Changes: The firms are not static; they respond strategically to changes in their environment. This includes adapting to new customer demands for more personalised and high-quality design outputs, and addressing shifts in the labour market, such as the noted labour shortages. Different firms within the big five have developed varied strategies to tackle these challenges, illustrating a spectrum of responses within a competitive yet collaborative framework.</p>		
<p>Soltani, S., Maxwell, D., & Rashidi, A. (2023). The State of Industry 4.0 in the Australian Construction Industry: An Examination of Industry and Academic Point of View. Buildings, 13(9), 2324–2324.</p>	<p>Resistance to Change: The study highlights a pervasive resistance to adopting Industry 4.0 technologies within the Australian construction industry. This resistance is rooted in the industry's traditional structure and a prevailing scepticism toward the tangible benefits of digital transformation.</p> <p>Integration of Advanced Technologies: Despite resistance, there is a recognised potential for significant improvements in efficiency and productivity through the integration of technologies such as AI, IoT, and digital twins. The research details examples where early adopters have begun to see benefits in terms of project management efficiency and reduced operational costs.</p> <p>Human Factors: The research underscores the necessity of addressing human factors alongside</p>	Australia	<p>Mixed-Methods Approach: The methodology combines qualitative and quantitative research, including structured interviews with industry leaders and an extensive review of secondary sources like industry reports and academic papers. This approach allows for a detailed understanding of both the micro (individual and organisational behaviour) and macro (industry-wide trends) aspects of Industry 4.0 adoption.</p> <p>Workshops and Focus Groups: Engaging directly with industry professionals and academics through workshops provided firsthand insights into the practical challenges and opportunities perceived by stakeholders.</p>

Citation	Key Findings	Geog. Region	Methodology
	technological changes. Concerns around job displacement, the upskilling of the workforce, and the integration of technology into daily workflows are crucial barriers that need addressing for successful technology adoption.		This method was particularly effective in gauging the readiness and attitudes towards digital transformation across different levels of the industry.
Kapliński, O., & Zavadskas, E. K. (2002). An overview of the problems related to research in construction engineering, management, and economics in Poland. Journal of Civil Engineering and Management, 8(4), 231–239.	<p>Alarming Phenomena: The research identifies several concerning trends within the field of construction engineering in Poland, including an increased number of staff with economic education, a high degree of feminisation in the workforce, financial constraints, and significant fluctuations in staff levels. These trends impact the operational dynamics and strategic direction of construction research and industry practices in Poland.</p> <p>Shift in Research Focus: Over the last decade, there has been a noticeable shift in research interests towards the organisation and management aspects of construction engineering, spurred by Poland's transition to a market economy. This shift has led to new research topics and a broader understanding of the construction industry's needs.</p> <p>Increased Emphasis on Education and Qualifications: There is a growing emphasis on academic qualifications and publications, but the study notes a struggle with forecasting the completion of doctoral theses due to unstable working conditions for researchers.</p>	Poland	<p>Survey-Based Research: The analysis is primarily based on a detailed questionnaire circulated among the members of the Construction Management Section of the Civil Engineering Committee of the Polish Academy of Science. This survey covered a broad range of topics over a ten-year period.</p> <p>Conference Proceedings Analysis: Insights are also derived from proceedings of national conferences organised under the auspices of the section, enhancing the depth of understanding regarding current research trends and issues.</p>
Schönbeck, P., Malin Löfsjögård, & Ansell, A. (2021). Collaboration and knowledge exchange possibilities between industry and construction 4.0	Integration of Technologies: The study highlights the critical need for integration of new technologies in both Industry 4.0 (manufacturing and production) and Construction 4.0 (architecture, engineering, construction, and operations sectors). The findings emphasise that strategic management and technological integration are essential for value creation throughout entire processes in Industry 4.0, whereas Construction	Global Industries	<p>Literature Review: The research is based on a systematic literature review of journal papers published in 2020. This method provides a comprehensive overview of current applications and research gaps in Industry and Construction 4.0.</p> <p>Quantitative and Qualitative Analysis: The study employs both quantitative (co-</p>

Citation	Key Findings	Geog. Region	Methodology
research. Procedia Computer Science, 192, 129–137.	<p>4.0 focuses more on bridging gaps between different sequential process actors.</p> <p>Similarities and Opportunities for Collaboration: Both fields share challenges related to data and information management, necessitating transformations to accommodate new digital landscapes. The research identifies potential interdisciplinary collaborations and knowledge exchange opportunities that could benefit both sectors, such as shared strategies for digital transformation and integration practices.</p> <p>Distinct Approaches in Application: The paper points out distinct approaches in how each sector applies these technologies—Industry 4.0 exhibits a more holistic approach integrating cross-organisational networks and end-to-end automated processes, whereas Construction 4.0 is more fragmented, focusing on specific digital innovations like Building Information Modelling (BIM).</p>		<p>occurrence analysis using MATLAB Text Analytics Toolbox) and qualitative methods to assess the content of relevant papers, enhancing the reliability and depth of the findings.</p>
Azman, N., Sirat, M., Pang, V., Lai, Y. M., Govindasamy, A. R., & Din, W. A. (2018). Promoting university–industry collaboration in Malaysia: Stakeholders’ perspectives on expectations and impediments. Journal of Higher Education Policy and Management, 41(1), 86–103.	<p>Existence of Cultural Barriers: There is a significant cultural divide between the operational styles and expectations of universities and industries in Malaysia. Industries perceive universities as inflexible and slow in adapting to rapid market changes.</p> <p>Mismatched Goals and Objectives: Universities and industries often operate with different timelines and objectives, which complicates collaboration efforts. Industries demand quicker, more definitive results which universities struggle to deliver due to their more exploratory and expansive research timelines.</p> <p>Issues of Trust and IP Rights: There’s a notable lack of trust between universities and industries, particularly regarding the sharing and protection of intellectual property. Industries are concerned about confidentiality and the proprietary nature of shared research outcomes.</p> <p>Inadequate Policy Framework: There are inadequacies</p>	<p>Malaysia</p>	<p>Qualitative Approach: The research employs in-depth interviews and focus group discussions to gather qualitative data from three distinct groups: academics, industry representatives, and policymakers.</p> <p>Purposeful Sampling: Respondents were selected through purposeful sampling to ensure a broad representation of experiences and perspectives across the academic and industrial spectrum in Malaysia.</p>

Citation	Key Findings	Geog. Region	Methodology
	<p>in the policies that govern university-industry collaborations, which are not effectively promoting or supporting these partnerships. There's a perceived lack of clear strategies or frameworks that both address day-to-day operational collaboration and outline benefits such as promotions or rewards for involved academics.</p>		
<p>Heesom, D., Olomolaiye, P., Felton, A., Franklin, R., & Oraifige, A. (2008). Fostering Deeper Engagement between Industry and Higher Education: Towards a Construction Knowledge Exchange Approach. Journal for Education in the Built Environment, 3(2), 33–45.</p>	<p>Effective Engagement Models: The study highlights two main approaches, the ACBEE and the CKE models, that facilitate deeper engagement between the construction industry and higher education. These models emphasise the value of structured, stepwise, and strategic partnerships that can evolve from simple awareness to complex strategic alliances.</p> <p>Action Learning and CPD: Central to the engagement process is the implementation of Continuing Professional Development (CPD) and Action Learning. These methods effectively introduce businesses to university capabilities and help them identify specific improvement needs which can then be addressed collaboratively.</p> <p>Benefits of Collaborative Projects: The research identifies clear benefits from collaborative projects, such as CPD training for SMEs, which not only introduce businesses to new capabilities but also provide practical, project-based learning opportunities for students. These collaborations help bridge the gap between theoretical knowledge and practical application, enhancing the educational experiences of students and meeting specific business needs.</p>	<p>UK</p>	<p>Comparative Case Study Approach: The research uses a comparative analysis of different engagement models (ACBEE and CKE) to determine their effectiveness in fostering industry-higher education collaborations. It employs detailed case studies to illustrate the processes and outcomes of these models.</p> <p>Action Research: The methodology involves participants actively engaging in identifying problems and testing out solutions through CPD and innovation circles, which are part of the Action Learning approach.</p>
<p>Tatum, B. (2018). Construction Engineering Research: Integration and Innovation.</p>	<p>Integration of Design and Construction: The paper emphasises the importance of integrating design and construction activities to improve project constructability. This includes early planning phases and the use of modularisation and preassembly.</p>	<p>United States</p>	<p>The study employs a case study methodology, where different construction projects are analysed to understand the impact of integration and innovation. It also uses model-based approaches to study</p>

Citation	Key Findings	Geog. Region	Methodology
Journal of Construction Engineering and Management, 144(3).	<p>Innovation in Processes and Products: The research highlighted case studies demonstrating innovative approaches in construction projects that led to enhanced project outcomes, such as increased efficiency and reduced costs.</p> <p>Knowledge and Tools for Improved Integration: It discusses the development and application of tools that aid in the integration of mechanical, electrical, and plumbing systems through model-based reasoning, enhancing coordination and reducing interferences.</p>		<p>and apply integration techniques, especially for complex systems like MEP coordination.</p>

Table 4. Literature Review of White Papers and Reports from Government Agencies and Other Sources

Reports	Geog. Region	Summary
Jones, K., Mosca, L., Whyte, J., Davies, A., Glass, J., 2021, The Role of Industry – University Collaboration in the Transformation of Construction, Transforming Construction Network Plus, Digest Series, No.4.	UK	<p>The report discusses the critical role of collaboration between industry and universities in advancing the construction sector. It emphasises the mutual benefits: universities gain access to real-world applications and data, enhancing research and academic outputs, while industry partners benefit from academic expertise, innovation, and development opportunities. It suggests enhancing these collaborations to address construction challenges more effectively, proposing structured engagements like joint research projects and sharing of knowledge through various platforms to drive transformation in the construction industry.</p>
Construction Expert Working Group, 2022. Construction Expert Working Group Scoping Study—March 2022.	Australia	<p>The report delves deeply into the challenges and potential of integrating Construction Technology (Construction Tech) within Australia's construction sector. It identifies a significant disparity in digital maturity levels across different sizes of companies, highlighting that smaller firms are less engaged with digital transformation. The study explores the barriers to technology adoption and emphasises the need for industry-wide collaboration and enhanced digital skills training. It proposes strategic recommendations to foster a more digitised, efficient, and competitive construction industry in Australia.</p>
Australian House of Representatives Standing Committee, 2022. Collaboration and contracts	Australia	<p>This article talks about Infrastructure, Transport, and Cities. It focuses on procurement practices for government-funded infrastructure. The main idea of the section titled "Collaboration and Contracts" involves assessing and enhancing collaboration and contractual practices in infrastructure projects to improve efficiency and effectiveness. This involves contributions from multiple committee members and experts within the Australian government framework.</p>
Infrastructure Australia, 2023. IA23 Market Capacity Report	Australia	<p>This report provides an evidence-based analysis of Australia's public infrastructure market, examining both demand and supply capacities. It highlights the growing demand for infrastructure against the current market's ability to deliver, with specific focus on constraints like labour shortages and material supply issues. The report emphasises the need for strategic government action to manage demand, improve supply chain efficiencies, and boost productivity across the sector. It includes recommendations aimed at enhancing workforce development, adopting new technologies, and improving construction practices to support sustainable infrastructure development across Australia.</p>
University of Melbourne, 2018. Improved design, planning and construction of schools: The	Australia	<p>The research on the Learning Environments Applied Research Network (LEaRN) has changed the ways schools in Australia are designed to improve environmental, sustainability and educational outcomes. LEaRN researchers partnered with representatives from the construction industry, architects and other professionals leading to the establishment of</p>

Reports	Geog. Region	Summary
<u>Learning Environments Applied Research Network (LEaRN)</u>		Australia's first peak body in prefabrication, prefabAUS, dedicated to improving prefab quality, productivity and affordability. LEaRN's research has been incorporated into the Office of the Victorian Government Architect 'Good Design + Education' publication, and research by LEaRN is informing a major policy change in school space allocation and the use of permanent prefabrication school buildings in Victoria.
<u>Australian Government, 2024. Increasing housing supply</u>	Australia	This report outlines the Australian Government's strategies to boost housing supply and affordability. Key initiatives include setting national housing targets under the National Housing Accord, incentivising states through financial rewards to exceed housing targets, and investing in essential infrastructure to support housing developments. Further measures include reforms to planning and zoning regulations, efforts to increase university student accommodation, and training more construction workers. The overarching goal is to manage and increase housing supply to meet future demands effectively.
<u>Building Commission NSW and Western Sydney University, 2023. How digital ready is the construction industry?</u>	Australia	This article evaluates the digital preparedness of the NSW construction industry. It finds that many businesses are at a basic stage of digitalisation, with significant barriers including the high costs of software and licenses. Despite challenges, there's a strong drive within the industry to enhance digital capabilities, motivated by the need for accuracy, quality, and efficiency in project delivery.
<u>Torrens University, Australia, 2021. Collaborative ways to address housing crisis</u>	Australia	Increased offsite manufacturing is predicted to improve housing supply by reducing construction time up to 80%. By integrating the supply chain through offsite manufacturing, this \$43 billion industry can prepare for a future where more construction occurs away from the building site. Offsite manufacturing can reduce materials waste by up to 90% and onsite accidents by up to 80%. The partners and researchers collaborated to develop a new model to implement offsite manufacturing for the housing sector.
<u>The University of Queensland, 2024. Timber efficiencies could help ease nation's housing crisis</u>	Australia	This report discusses how improving timber production efficiencies could significantly alleviate Australia's housing crisis. Researchers at the ARC Advance Timber Hub found that even a 5% increase in timber production efficiency could enable the construction of an additional 8,000 homes annually. The focus is on enhancing the entire supply chain from forest to building, utilising advanced technologies such as AI and robotics to maximise material use and improve productivity.
<u>iBuild Building Solutions, 2021. Research collaboration on remote housing construction boosted by government funding allocation</u>	Australia	This report discusses a collaborative research project aimed at enhancing housing construction in remote areas, supported by government funding through the Australian Research Council. The project, involving iBuild and three Australian universities, focuses on developing a building assembly system using fibre-reinforced composites to create durable, lightweight housing suitable for harsh climates. The research addresses significant

Reports	Geog. Region	Summary
		challenges such as high material transport costs and the harsh environmental conditions of remote regions.
CPB Contractors, 2024. Collaboration continues: CPB Contractors, TAFE NSW, and Western Sydney University deliver three new microskills for IAT-C	Australia	This article discusses their collaboration with TAFE NSW and Western Sydney University to launch three new microskill courses at the Institute of Applied Technology—Construction (IAT-C). These courses are aimed at addressing skills shortages in the construction industry and increasing female participation. The courses focus on introducing women to construction, sustainability in construction, and the role of Building Information Modelling (BIM). Additionally, 60 fee-free training places are offered to encourage more women to join the sector.
Green Building Council Australia, 2021. Case studies - University of Melbourne Fishermans Bend campus	Australia	The University of Melbourne is developing its Fishermans Bend campus as a "living laboratory" for sustainable construction and innovative technologies. This new campus focuses on green building practices and aims to push the boundaries of current construction methods. It provides state-of-the-art facilities for research and development, with an emphasis on sustainability in architecture and engineering. The campus is set to become a hub for advanced manufacturing, energy-efficient systems, and sustainable urban development.
Martin Loosemore, 2016. How Relevant Are Australian Universities to Construction Innovation?	Australia	This article discusses the relevance of Australian universities to construction innovation, emphasising the National Innovation and Science Agenda's push to measure academic research impact based on real-world applications. This involves enhancing human capital capabilities crucial for innovation and addressing the disconnect between academic research and industry needs. It highlights the need for universities to adapt and engage more practically with the construction industry to make their research more applicable and valuable.
David Chandler OAM, 2024. The Australian Construction Industry has Amongst the Lowest Rates of Investment in Research and Development in our Economy	Australia	This report highlights the low investment in research and development in Australia's construction industry, which is crucial for modern construction innovations. It emphasises the need for the industry to engage more with academia to foster innovation and improve practices, particularly through collaborative efforts like those at the university's Centre for Smart Modern Construction. This centre aims to bridge the gap between academic research and industry needs, preparing future constructors with relevant skills and knowledge.
Victoria State Government, 2022. Construction Industry Insight	Australia	This report outlines the workforce and skilling needs of Victoria's construction sector through 2025. It details the expected growth in employment, identifies critical occupations, and emphasises the importance of enhancing skills, particularly in areas like digital technologies and sustainable practices. It advocates for stronger collaborations between industry,

Reports	Geog. Region	Summary
		government, and educational institutions to address skill shortages and improve workforce retention and diversity.
<u>Sam Burt, 2020. More than half of construction industry insiders think industry is not sustainable, a study finds</u>	Australia	A University of Melbourne study has revealed that over half of construction industry insiders surveyed perceive the industry as unsustainable. This sentiment is based on current practices and attitudes within the sector, despite its significant contribution to Australia's GDP and employment. The study suggests that improvements in risk allocation and collaboration could enhance sustainability and efficiency, offering substantial community and economic benefits. The report underscores the need for strategic changes to foster a healthier construction industry.
<u>Professor Martin Loosemore, 2019. Australia's construction industry must unite around a cohesive strategy</u>	Australia	This article discusses the need for Australia's construction industry to adopt a unified strategy to remain competitive globally. It highlights the urgency of embracing Industry 4.0 technologies and modern construction methods to improve efficiency, sustainability, and integration across the sector. The narrative underscores that while Australia is recognised for its project management capabilities, it lacks the cohesive reform strategies seen in other nations, which could potentially hinder its future competitiveness in the global market.
<u>Leigh Dawson, 2021. Construction industry gets automated at new Monash University facility</u>	Australia	Monash University is advancing the construction industry with a new facility focused on automation and robotic technology. Funded by an Australian Research Council grant, the facility aims to specialise in automated prefabrication and building processes, aiming to enhance productivity, safety, and cost-efficiency. This initiative can potentially transform the traditionally labour-intensive construction sector by incorporating advanced robotic technologies and automated systems.
<u>Sasha Menon, 2023. Safety in Construction: Latest University of Melbourne Report Finds Majority Believe Tech Makes a Positive Difference</u>	Australia	This report examines the role of technology in enhancing construction quality and safety. It identifies significant challenges and opportunities for technology adoption across Australia and Singapore, focusing on issues like data management and safety protocol integration. The report advocates for the strategic use of technologies like Building Information Modelling (BIM) to improve construction processes and outcomes.
<u>Master Builders Victoria, 2023. Master Builders Victoria leads International Research Project with RMIT University to Examine Post-Covid Global Best Practice for Victorian Building Industry</u>	Australia	Master Builders Victoria, in partnership with RMIT University, has launched an international research project to identify global best practices for Victoria's building industry post-COVID. The initiative involves studying industry innovations worldwide to ensure the local industry's future resilience and global competitiveness. The project aims to enhance workforce skills, adopt new construction methodologies, and improve industry sustainability and preparedness.

Reports	Geog. Region	Summary
ARC Communications, 2024. More than \$64 million in funding to support research partnerships	Australia	<p>The Australian Research Council (ARC) has allocated over \$64 million in funding to support 6 new Industrial Transformation Training Centres and 7 Research Hubs. These initiatives aim to foster industry-university research collaboration in sectors like digital technology for the water sector and construction, enhancing Australia's innovation capacity and addressing critical industry challenges.</p>
Nicola Brackertz, Tom Alves, Kylie Valentine, Hazel Blunden, Megan Blaxland, Ilan Katz, 2023. Together Home Program Evaluation	Australia	<p>The Together Home Program (THP) launched by the NSW Government aims to support people experiencing homelessness by providing stable accommodation and comprehensive support services. This initiative, backed by significant government funding, seeks to address street homelessness through a Housing First approach, integrating health and well-being services tailored to the needs of individuals. The program involves multiple community housing providers across NSW, and its evaluation by AHURI and the Social Policy Research Centre examines its effectiveness and suggests future improvements.</p>
Dr Tharaka Gunawardena, University of Melbourne; Joyce Ferng, AECOM; Professor Tuan Ngo, University of Melbourne; Professor Shan Kumar, Swinburne University of Technology and Professor Priyan Mendis, University of Melbourne, 2023. How Australia's prefab industry can help the housing crisis	Australia	<p>This report discusses how Australia's prefabricated (prefab) housing industry can contribute to alleviating the housing crisis. It suggests that prefab construction offers a faster, more cost-effective, and environmentally sustainable alternative to traditional building methods. By integrating modern manufacturing techniques, the prefab sector can significantly increase the supply of affordable housing, addressing the urgent need for housing solutions in Australia.</p>
Believe Housing Australia and University of South Australia, 2022. Beyond the Housing Crisis – A Home for All	Australia	<p>This article highlights their collaboration with the University of South Australia to address South Australia's housing crisis. The initiative aims to create a unified strategy and action plan, emphasising the need for immediate, national coordination to tackle the root causes of housing issues, particularly affecting vulnerable groups. The program calls for investment in housing solutions that deliver broad social and economic benefits.</p>
People's Commission and University of Sydney, 2024. Everybody's Home: National conversation about the housing crisis	Australia	<p>This report discusses the "Everybody's Home" initiative, which has convened Australia's first People's Commission into the Housing Crisis. The commission reveals severe housing stress, with many Australians skipping essential services and meals to cope with costs. It emphasises the urgent need for real solutions and long-term reform to address the housing crisis, based on insights from affected citizens and submissions from various organisations.</p>

Reports	Geog. Region	Summary
Ryan Johnson, Urban Development Institute of Australia (UBIA), 2024. Report: Australia faces decade-low housing supply crisis	Australia	Australia is experiencing a significant housing supply crisis, with a decade-low in housing availability projected to exacerbate affordability issues. The Urban Development Institute of Australia's report emphasises the disconnect between government initiatives aimed at increasing housing stock and the actual outcomes needed to address land supply and labour shortages effectively. There are calls for more decisive action to ensure sufficient development-ready land to meet housing demands.
AHURI, 2024. AHURI announces the funded research activities of the 2024 National Housing Research Program	Australia	AHURI has announced the funded research activities for the 2024 National Housing Research Program. This program includes a major inquiry into construction constraints affecting housing supply and 14 research projects addressing various aspects of housing system challenges, such as affordability, homelessness, and technological innovations. The program aims to provide comprehensive insights and solutions for Australia's housing issues through collaborative research and policy development.
Will Venn, 2023. How research provides the keys to unlocking Australia's housing crisis	Australia	The University of South Australia discusses the importance of research in addressing Australia's housing crisis. The article emphasises the historical context that has led to the current state of housing affordability and explores potential solutions through policy and innovation. The focus is on developing evidence-based strategies to mitigate housing challenges, ensuring equitable access to housing across different generations and demographics.
University of Melbourne, 2024. Transforming prefabricated housing for the better	Australia	The University of Melbourne, through a partnership with industry and other universities, is enhancing prefabricated housing to address Australia's housing crisis. This research, part of the Building 4.0 CRC initiative, focuses on making prefabricated housing safer, more affordable, and sustainable. Innovations include new building materials and efficient construction techniques suited for various environments, including areas prone to natural disasters.
UNSW Sydney, 2021. Housing and the Economy: Scenarios for Australia to 2025 and 2045	Australia	This article aims to understand the impacts of COVID-19 on the housing system and future economic scenarios. It explores the connection between housing, productivity, and stability through expert opinions and targeted research, aiming to inform better policymaking for housing sustainability in Australia.
Mark Degotardi, 2024. Housing Matters Autumn Edition	Australia	This article discusses significant initiatives and advocacy efforts to address NSW's housing crisis. It highlights the pre-Budget submission advocating for substantial investment in social and affordable housing and presents an overview of events like the Big Housing Debate, which focused on enhancing housing solutions. The edition also celebrates new graduates from the Cadetship Program, underlining the ongoing commitment to community housing and education in the sector.

Reports	Geog. Region	Summary
Master Builders Association, 2024. 2024 industry forecasts are out now	Australia	Master Builders Australia has released the 2024 industry forecasts for the construction sector, covering up to 2028-29. The forecasts highlight an optimistic medium-term investment climate due to expected interest rate decreases and controlled inflation. However, challenges such as workforce shortages and industrial relations could impact the housing supply goals. The report emphasises the potential positive impact of federal government housing initiatives yet notes a shortfall in meeting housing targets across states and territories without further policy support.
The Urban Developer, 2024. Construction Leaders' Strategies to Combat Headwinds in 2024.	Australia	This report discusses how Australia's construction industry leaders are strategising to handle current challenges like high material costs, labour shortages, and market volatility. Emphasising the need for sector diversification, especially into high-growth areas like healthcare, leaders are exploring new strategies for talent acquisition and project acquisition to maintain competitiveness and meet the evolving demands of the market.
Build Australia, 2024. Budget 2024-25 boosts housing and construction	Australia	The 2024-25 Federal Budget in Australia introduces several measures aimed at enhancing housing supply and supporting the construction sector. This includes collaborations with various government levels to implement reforms that boost housing affordability, tax incentives for new constructions, increased funding for social housing, and investments in training for the construction workforce. These initiatives are part of the broader National Housing Accord effort to address the housing shortage.
Australian Centre for Housing Research at the University of Adelaide and Australian Research Council, 2023. Our Housing Australia	Australia	The Australian Centre for Housing Research at the University of Adelaide has launched a multi-year national housing data infrastructure project to provide insights into the living conditions within Australian homes. This project, funded by the Australian Research Council, involves a consortium of six universities. It aims to deepen the understanding of housing conditions across various demographics and regions, supporting policy development and community planning.
Australian Broadcasting Corporation, 2022. Regional housing crisis solutions involve community partnerships, research finds	Australia	New research finds medium density developments, affordable housing initiatives and repurposing buildings could solve the regional housing crisis. School leavers, older people and people experiencing homelessness were consulted as part of the University of Melbourne research. The report provides other regional communities a blueprint to move forward from the housing crisis
Boston University, 2024. The Global Housing Crisis: Lessons on Displacement, Affordability, and Homelessness	Global	The event "Research on Tap: The Global Housing Crisis" at Boston University focused on the wide-reaching impacts of housing unaffordability. Experts discussed how housing issues affect health, social equity, and economic mobility, emphasising the need for comprehensive solutions to displacement and homelessness. The session highlighted housing as a human right and called for collaborative efforts to address the crisis.

Reports	Geog. Region	Summary
Institute of Public Affairs, 2023. Australia's Housing Shortage	Australia	<p>This report examines the impact of international student intake on Australia's housing supply, highlighting a significant shortfall. It notes that a record number of international students are exacerbating the housing crisis by occupying a substantial portion of new housing units, which intensifies rental shortages and inflates rental costs. The report calls for better management of international student numbers and housing supply to alleviate this issue.</p>
University of Newcastle, 2023. New analysis: housing need significantly underestimated	Australia	<p>This article suggests that the housing need in Australia is significantly underestimated. The study critiques current methods of assessing housing demand, highlighting that they don't account for changing household patterns, pre-existing shortages, or the true dynamics of housing markets. It advocates for an approach that better aligns with actual demand and includes forward planning for infrastructure on zoned land to ensure new housing can be developed effectively.</p>
AHURI, 2024. Challenge to supply affordable regional housing needs strategic focus	Australia	<p>This article addresses the challenge of supplying affordable housing in regional Australia. It emphasises that regional housing markets face unique issues compared to metropolitan areas, such as labour shortages and logistical costs due to distance from suppliers. The report suggests that strategic government action is needed to support housing development in these areas, potentially involving national strategies to enhance supply chains and stabilise market conditions.</p>
AHURI, 2024. Disruption in regional housing: Policy responses for more resilient markets	Australia	<p>This report discusses the significant challenges faced by rural and regional housing markets in Australia, highlighting issues like poor affordability, under-developed supply chains, and labour shortages. The report stresses the need for strategic government action to invigorate these markets by making substantial investments, developing stronger supply chains, and ensuring sustained labour availability to support construction activities. It advocates for a national strategy to provide certainty for private investment and to harness potential government support.</p>

#56 Accelerating B4.0CRC Translation and Impact

Appendix 2: Invitation to Participate in Focus Group Discussion

Dear Researchers at University of (Name),

The CRC is excited to invite you to participate in Project 56, “Accelerating Building 4.0 Research Translation & Impact!”

We’re delighted that your research organisation is involved and are looking forward to working with you to support the CRC’s vision of developing a thriving Australian advanced manufacturing sector by enabling industry to direct and draw on Australian research through a scalable methodology that upskills researchers and industry professionals in collaboration, engagement, and adoption of innovations.

We’d like to invite you to participate in the first formal Project 56 activity, a discussion forum. You can attend the discussion forum either in person, or online as outlined below.

In person, at B4.0 headquarters in Caulfield on Tuesday December 5, between 2:00 and 4:00 pm.

or

In an online format on Wednesday December 6, between 9:00 and 11:00am

Please click the links above to register for either forum. Please pass this on to colleagues who might be interested. Registration closes on Monday Nov 27.

These will be facilitated discussion forums with B4.0 CRC industry partners participating in the project, Melbourne, Monash, and QUT researchers, and the CRC executive team. The goal of the discussion is to identify:

- Barriers to effective research translation
- Enablers of effective research translation
- Current practices in research–industry collaboration.

Outputs from the discussion forums will help us refine the next stage of the project: professional development programs for project participants to develop researchers’ and industry partners’ engagement and collaboration leadership capabilities.

We’re looking forward to hearing your observations and reflections on the barriers and enablers to effective research translation and adoption, especially in the context of collaborative research projects and partnerships.

At the end of the discussion forums, we will give more details of the professional development programs which will commence in 2024.

The forums are open to all researchers involved in B4.0 CRC projects, and anyone involved with B4.0 CRC projects at the industry partner organisations participating in this project.

If you have questions about the discussion forums or the project, please let us know.

Kind regards,

Chris

Prof
Research
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Chris
Director,

Knapp
Building

PhD
4.0

RAIA
CRC

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Appendix 3: Questionnaire for Survey (pre-training module)

Consent Form

Dear Participant,

Thank you for your active participation and contribution to the Building 4.0 CRC Project 56 “Accelerating Building 4.0 Research Translation & Impact”.

We are seeking your inputs via short questionnaires before and after the Training Program to gather your training experiences, observations and experiences of enablers and barriers to effective research translation and impact.

Please submit your response before the training program begins.

We will be consolidating these inputs from B4.0CRC researchers and industry partners for this project and aggregate findings will be presented at Building 4.0 CRC Showcase Event 2024.

Thanks again for your time and inputs. Please reach out to me via email in case of any queries.

Warm regards,

Niharika

Associate Professor of Niharika Garud
University Melbourne
niharika.garud@unimelb.edu.au

Options:

Please proceed with the questionnaire. (1)

I do not want to provide inputs (kindly close the browser). (2)

Questionnaire Page 1:

Which of the following options describe you the best:

I work at a university or a research organisation conducting core research (1)

I work in the industry in a non-academic organisation (2)

What is your Age?

18–25 (1)

26–30 (2)

31–35 (3)

- 36–40 (4)
- 41–45 (5)
- 46–50 (6)
- 51–55 (7)
- 56–65 (8)
- above 66 (9)

What is your gender?

Male (1)

Female (2)

Other (3) _____

Prefer not to say (4)

Q5 – Time Pressure

At my university in general,

I feel pressed for time at my work. (1)

I always feel under time pressure while working. (2)

I feel rushed. (3)

Compared to previous years, I feel more stressed about my time. (4)

I feel pressed for time. (5)

I feel stressed out. (6)

I feel like I don't have enough time. (7)

Q6 – At my university in general,

I feel it is difficult to gather leadership support for adopting research-based solutions in industry. (1)

I feel it is difficult to gather resources (such as capital/budget, staff time) for adopting research-based solutions in industry. (2)

I find it challenging to visualise how we can practically implement our existing research projects in creating industry solutions. (3)

I feel it is challenging to create research project structures that allow researchers and industry practitioners to operate together in the same research project. (4)

I find it is difficult to gain credibility for research projects among industry partners. (5)

I feel that I will lose credibility if I champion too many research projects that are industry/practice focused. (6)

Q7 – Collaboration

At my university in general,

High quality research performance benchmarks make industry collaborations slower. (1)

High quality research performance benchmarks make industry collaborations costlier. (2)

It is challenging to share our data with external industry partners. (3)

It is challenging to receive/gather data from external industry partners. (4)

It is difficult to communicate effectively with industry partners. (5)

It is hard to create risk management plans for research projects which involve external industry partners. (6)

Q8 – As a researcher,

I think creating new knowledge through core research is more important than applying existing knowledge in industry settings. (1)

I feel there is a gap between academic research outputs, and the kind of research outputs industry expects me to produce. (2)

I find it challenging to design research projects that can be effectively adopted in industry. (3)

I find it challenging to design research projects that have real-world impact. (4)

I find it hard to explain to industry partners how my research project can contribute to practice. (5)

I feel it is difficult to gather industry support (such as sponsorship, funding, data access) for research projects in general. (6)

Q9 – In your opinion, what kind of skills are required for effective research translation for practice/industry impact and for enabling effective industry-academic collaborations? Please write your response in a short paragraph or using bullet points (kindly write at-least 150 words).

Q10 – In my experience, industry-academic collaborations have worked well when.....

We have invested in prototyping of our research findings within our research project plans. (1)

We have designed KPIs to encourage research-based practical solutions within our projects. (2)

We have included examples of practical implementation of research in projects. (3)

We included experienced individuals or experts in research translation in our projects at early project stages. (4)

We focused on creating collaborative environment to overcome cultural gaps while collaborating with industry partners. (5)

We invested resources to align stakeholders for facilitating industry-research collaboration. (6)

We invested resources to gather advocates for facilitating industry-research collaboration. (7)

Q11 – Time-pressure

At my organisation in general,

I feel pressed for time at my work. (1)

I always feel under time pressure while working. (2)

I feel rushed. (3)

Compared to previous years, I feel more stressed about my time. (4)

I feel pressed for time. (5)

I feel stressed out. (6)

I feel like I don't have enough time. (7)

Q12 – At my organisation in general,

I feel it is difficult to gather leadership support for adopting research-based solutions. (1)

I feel it is difficult to gather resources (such as capital/budget, staff time) for adopting research-based solutions. (2)

I find it challenging to visualise how we can innovate in our existing projects using research-based solutions. (3)

I feel it is challenging to create project structures that allow researchers and industry practitioners to operate together in the same project. (4)

I find it is difficult to gain credibility for projects that are based on research-based solutions. (5)

I feel that I will lose credibility if I champion too many projects based on research-based solutions. (6)

Q13 – Regulatory Compliance

At my firm in general,

Regulatory compliance makes innovating slower. (1)

Regulatory compliance makes innovating costlier. (2)

It is challenging to share our data with external research partners. (3)

It is difficult to communicate effectively with research partners. (4)

It is hard to create risk management plans for projects which involve external research partners. (5)

Q14 – In my organisation, industry-academic collaborations have worked well when...

We have invested in prototyping. (1)

We have designed KPIs to encourage research-based solutions. (2)

We have included examples of practical implementation of research in projects. (3)

We included experienced individuals or experts in research translation in our projects at early project stages. (4)

We focused on creating collaborative environment in the project to overcome cultural gaps while collaborating with research partners. (5)

We invested resources to align stakeholders for facilitating industry-research collaboration. (6)

We invested resources to gather advocates for facilitating industry-research collaboration. (7)

Q15 – In your opinion, what kind of skills are required for research translation in industry and for enabling effective industry-academic collaborations? Please write your response in a short paragraph or using bullet points (kindly write at-least 150 words)

Q16 – In your opinion, what kind of skills are required for research translation in industry and for enabling effective industry-academic collaborations? Please write your response in a short paragraph or using bullet points (kindly write at-least 150 words)

Q17 –In your opinion, what kind of skills are required for research translation in industry and for enabling effective industry-academic collaborations? Please write your response in a short paragraph or using bullet points (kindly write at-least 150 words)

Appendix 4: Invitation to Participate in In-Depth Qualitative Study

Greetings from the University of Melbourne! Hope you are doing well.

We would like to gather your inputs via a short interview for our research project “Accelerating B4.0 CRC Translation and Impact” within the Building 4.0CRC initiative (project link). This project focuses on exploring the gaps between academic research and industrial applications, specifically focusing on understanding the challenges in translating research into industry practices, which is why we would highly value your inputs given your experience with CRC projects and industry collaborations.

It would be great if you can do a Zoom interview (30 mins to 45 mins) with us during coming days, scheduled as per mutual availability and convenience. Kindly let us know if you would be able to meet us via Zoom during any of the following slots (we will send you an invitation):

April 15 (Mon): 10-11am, 12-2pm, 2.30-4pm

April 16 (Tue): 11-12pm, 1-4pm

April 17 (Wed): 10-11am, 3-4pm

April 18 (Thu): 1-3pm

April 19 (Fri): 1-3pm

Once we hear back from you, we will send you the discussion questions attached to the invitation (this is for your reference, you do not need to go through them in advance).

Your contribution would be immensely valuable to our project, and we greatly appreciate your willingness to share your time and expertise.

For any further information or questions, please feel free to contact us. Thank you for considering our invitation. We look forward to hearing from you in this regard.

Warm Regards

Niharika and Lara

Appendix 5: Interview Protocol for In-Depth Qualitative Study

Welcome and Introduction (common for industry practitioners and research leaders)

Thank you for agreeing to participate in this research project. We extend our warmest greetings from the University of Melbourne and the Building 4.0 CRC project team. Given your experience with CRC projects and industry collaborations, we would highly appreciate your inputs for this project. The project will contribute to enhancing our understanding of challenges and drivers of research translation and impact in Australia's advanced manufacturing sector.

Your inputs will be kept completely confidential and will not be shared without anyone outside the research team. Once we transcribe your inputs, we will mask your identity and remove any identifying information to analyse the data. Only aggregate results will be shared and presented. The preliminary findings from this project will be presented at the Building 4.0 CRC Showcase Event in May 2024.

QUESTIONS SENT TO INDUSTRY PRACTITIONERS

Section 1

1. How do time constraints affect the balance between the industry's need for quick solutions and the time-consuming nature of research?
2. What challenges in credibility and project structure hinder innovation and risk management?
3. How does misalignment between research goals and funding, coupled with poor communication and data sharing, limit research impact?
4. How do complex regulatory environments and the presence of many stakeholders slow down research adoption and complicate policy-related initiatives?

Section 2

5. How do targeted KPIs and showing examples encourage innovation and the practical implementation of research?
6. In what ways do prototyping and genuine collaboration bridge cultural gaps and foster a conducive project environment?
7. How does early stakeholder alignment and advocacy for research in the industry facilitate smoother project scalability and collaboration?
8. How does leveraging experienced individuals to translate research into industry applications overcome scepticism and showcase impact?

QUESTIONS SENT TO RESEARCH LEADERS/RESEACHERS

Section 1

1. How does a gap between research findings and their practical application prevent effective adoption and real-world impact?
2. How do time constraints affect the balance between the industry's need for quick solutions and the time-consuming nature of research?
3. What challenges in credibility and project structure hinder innovation and risk management?
4. How does misalignment between research goals and funding, coupled with poor communication and data sharing, limit research impact?
5. How do complex regulatory environments and the presence of many stakeholders slow down research adoption and complicate policy-related initiatives?

Section 2

6. How do targeted KPIs and showing examples encourage innovation and the practical implementation of research?
7. In what ways do prototyping and genuine collaboration bridge cultural gaps and foster a conducive project environment?
8. How does early stakeholder alignment and advocacy for research in the industry facilitate smoother project scalability and collaboration?
9. How does leveraging experienced individuals to translate research into industry applications overcome scepticism and showcase impact?



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