Enablers and barriers to industry-research collaboration

A small and medium sized enterprise perspective

RMIT
UNIVERSITY

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Acknowledgements

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CSIRO foreword

Small to medium enterprises (SMEs) have often been called the backbone of the Australian economy, and for good reason. They employ 68 per cent of Australia's population, account for 99.8 per cent of all our businesses, and contribute more than half of our GDP.

SMEs are prolific across Australia, and the potential for science and technology to power their innovation and growth is enormous.

This report is the voice of SMEs. CSIRO has partnered with RMIT University to undertake one of Australia's largest ever surveys of business leaders, conducting more than 800 interviews to learn directly from SMEs about the drivers and barriers for collaboration with Australia's world-class research sector.

By understanding the research and development needs of SMEs, our goal as Australia's innovation catalyst is to help facilitate connections with research to help SMEs grow, gain a competitive advantage, and thrive.

The survey revealed many insights, but crucially, it found that science, technology, and collaborative innovation are key enablers for SME growth.

In fact, collaborating SMEs were more successful overall — they were more likely to introduce new-to-market innovations, had higher turnover, and were better able to cope with uncertainty and change, like disruption caused by COVID-19.

As one of the world's largest mission directed organisations, with strong connections to both industry and research institutions, we know the value and impact of true collaboration.

The question is, how do we develop a coordinated, national approach to SME-research collaboration so that those 99.8 per cent of Australian businesses can realise the value and innovation-led growth that solutions from science can bring?

CSIRO, together with our partners across more than 3,000 customers and every Australian university, is developing an SME Collaboration Nation mission aimed at doubling the number of SMEs engaging with publicly funded research by 2025.

This is part of a broader program of missions in development by CSIRO and partners targeted at the future prosperity and resilience of Australia.

This report provides the insights, tools, and understanding of which enablers should be boosted to help achieve that goal, and a picture of where SMEs can gain competitive advantage with research and other support.

It also identifies where we can work to remove barriers and enable valuable connections for success.

CSIRO already provides support for SMEs through our SME Connect offerings and initiatives, including the Federal Government's Innovation Connections programme, which supports businesses to develop and bring new products to market.

There is a growing ecosystem of support for SMEs from CSIRO and others, because when SMEs thrive, so does Australia.

It is my hope that the insights in this report will help Team Australia better support the sector that supports Australia, and catalyse a new era of SME innovation that will speed our economic recovery.

Dr Larry Marshall
Chief Executive, CSIRO

RMIT University foreword

The Australian company landscape is dominated by small and medium size enterprises (SMEs). Continued economic prosperity for Australia is dependent on many Australian SMEs thriving in highly competitive global markets. SMEs need to be excellent operationally, demonstrating world's best practice, and offering products and services with a comparative advantage, usually in both price and performance. SMEs need to be able to respond to emerging technologies, including technologies that are disruptive to current business models. Competitive advantage can be obtained by including the outcomes from research in their businesses, whether those outcomes be new and/or improved processes, products and services.

Australia's universities and research institutes (URIs) possesses world class research capability. Many also have a strong desire to deliver benefit beyond that obtained through advancing their research disciplines. Many are driven to provide substantial benefits to the communities in which they operate. These benefits can be economic, environmental and societal.

Australian URIs are evolving their research and innovation ecosystems, and refining their understanding of pathways to impact, to positively engage beyond the academic community. Impact literacy is growing within URIs. With understanding comes the recognition that the delivery of impact from URI research generally requires others to pick-up the assets that are created by the URIs and to ultimately realise the impact.

Research is frequently defined as the generation and dissemination of new knowledge while innovation is defined as turning knowledge (new and/or existing) into positive impact, in terms of benefits to the economy, society and environment. It is important for URIs to understand the value chain commencing from inputs and moving sequentially through to activities, outputs, outcomes (valuable asset creation) to finally impact and derived community benefits. In the research and innovation space, URIs create value but the ultimate impact, such as a new product, process, service, business model, regulation or policy, is generally delivered by another organisation. Hence, external engagement, involving relationships and partnerships, is critical to having a successful URI research and innovation portfolio focused on translation.

URIs are involved in value creation and need to understand where the value can be delivered to and how that entity will capture the value and deliver the impact. Ideally SMEs should be prospecting for business opportunities emerging from URIs.

Partnering is an imperative. Partnering early in the research and development stages is preferred. One measure of success for impact-focused URIs is encompassed in the statement that URIs are successful when their partners are successful – partnering for success. For example, CSIRO and RMIT already have partnering as a measure of success.

Overall, the Australian national innovation ecosystem is far from optimised. Partnering between SMEs and URIs can be markedly improved.

In the current discussion on maximising university research commercialisation, it is critical that we do not lose sight of the enormous benefits that can be derived from URIs working with existing firms, including SMEs.

SME growth, or even SME sustainability, requires progression of business relevant innovation agendas. Frequently SME cash flow is a constraint on actualising innovation aspiration. This is where government can have a role; targeting innovation support schemes for SMEs to partner with URIs.

Anyone interested in better understanding the importance of SME-URI engagement in the Australian context should read this CSIRO-RMIT report.

I commend the authors for this well-researched report on a very important topic for Australia.

Professor Calum J. Drummond AO
Deputy Vice-Chancellor and Vice President
Research and Innovation, RMIT University

Executive summary

It is well documented that collaborations between small and medium enterprises (SMEs) and Universities and Research Institutes (URIs) lead to ecosystem knowledge exchange, an industry-ready workforce, and new and improved SME products and processes. These, in turn, propel innovation, competitiveness, productivity, and internationalisation. Yet, researchers and policy-makers identify much room for improvement in the quality and quantity of SME-URI collaborations in Australia.

RMIT University was commissioned to investigate why some Australian SMEs engage with URIs for research translation and research and development (R&D) while others do not. Furthermore, they were asked to provide evidence-based recommendations to improve the frequency and impact of SME-URI collaborations in Australia. To do this, they:

- uncovered the antecedents, dynamics and outcomes of successful SME-URI collaboration cases
- compared a range of enablers, barriers, motivations, outcomes and types of collaborative activities for SMEs engaging vs. not engaging with URIs
- presented an agenda of practical and policy recommendations for URIs, SMEs and other stakeholders.

A four-stage research design (Figure 1) was followed, drawing on data from different sources, including existing literature and media, background data, and interviews with stakeholders, to inform a phone survey of 400 'collaborators' and 400 'non-collaborators'.

Collating the survey data with the literature and interviews enabled the identification of a number of important findings.

SMEs engage in such partnerships when they perceive the derivative value of R&D and information and knowledge spillovers generated from the collaboration with URIs to be significant. The extent to which SMEs are inclined to engage in university–industry partnerships varies across industries and is influenced by the availability of financial incentives, public funding (Doh & Kim, 2014) and place-based innovation policies (Bellucci et al., 2019).

Focusing on the importance, rather than the incidence, of SME-URI collaboration, the findings indicated fewer than 15 per cent of all businesses undertook their innovative activities mainly with URIs. Yet collaborating firms were significantly more likely to introduce new-to-industry innovations, especially in the important areas of service and product innovation. This indicates these collaborations are important in providing a competitive edge. They also tended to innovate more broadly than non-collaborating firms. The narrative emerging from collaborating SMEs highlighted a two-way flow of benefits, while non-collaborating SMEs focused very much on training-related collaborations.

Stage 1A
Systematic literature review

Stage 1B
Media analysis

Stage 2
Desktop analysis

Stage 3
Interviews and focus groups

Stage 4
Survey

5-step review process of 98 articles in peer-reviewed academic journals

Analysed articles from 19 Australian periodicals

Analysis of background data to inform survey design

With owners/managers of collaborating SMEs, URI researchers, administrators and innovation facilitators

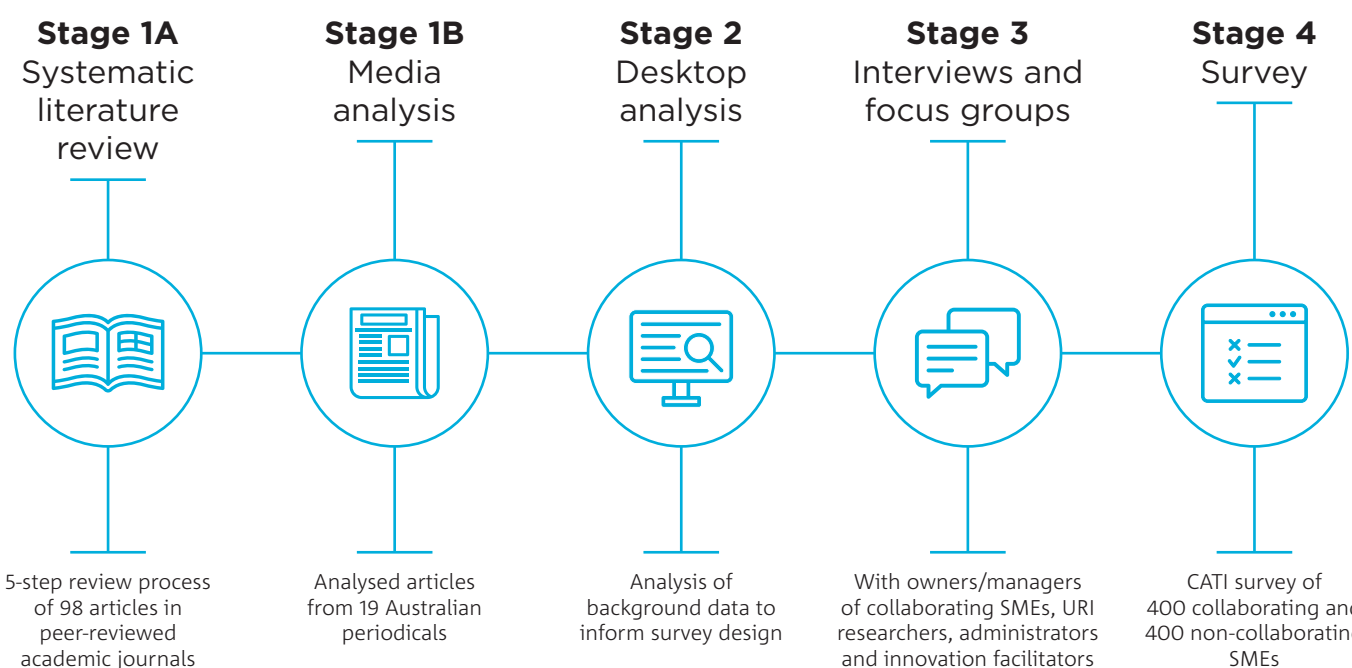CATI survey of 400 collaborating and 400 non-collaborating SMEs

Figure 1: Research method

It was found business size often mattered in how SMEs behaved. Very small firms were focused on low-touch activities, such as attending seminars, as well as on joint research activities they self-funded. SMEs with between five and 19 employees ranked highest on collaboration activities. In terms of age, more mature firms were less likely to collaborate, especially once they were older than 20 years. It is likely that these older, larger firms were more self-contained, and only sought out collaborations for very specific purposes.

Although firms were given the same list from which to choose the factors that enabled or provided barriers to innovation, their responses differed vastly. Enablers tended to be resource-oriented, for example focused on funding, cost-effectiveness and extending resources. In contrast, barriers tended to be relationally focused, for example trust and mutual commitment.

When comparing collaborators and non-collaborators, collaborators found enablers such as a match of rigour and relevance, ability to navigate URIs' structures, delivery timeframes and internal resources significantly more important than non-collaborators. The same comparison across barriers showed that lack of previous experience, an existing relationship, mutual commitment to the collaboration and the lack of a collaboration champion were significantly more important to collaborating than non-collaborating firms. Operational enablers and relational barriers therefore tended to be more important for collaborators than non-collaborators.

Analysis of the interview and focus group yielded important information about the nature of SME-URI collaborations, but also the most important barriers and enablers of those collaborations. These data highlighted enablers such as the key role of facilitators, the importance of government support (funding and other), good communication and relationships, matching business needs with research capabilities and having business staff with technical expertise.

When barriers were investigated, it showed that key themes in the data were difficulties in managing expectations and timing between researchers and SME participants, limited funding, dealing with URIs and their bureaucracy, concerns about IP, uncertainty about the value of involvement, and differing motivations of URIs and SMEs to collaborate.

Furthermore, interviews with URI managers highlighted that different organisational units (e.g., research, teaching or administrative) might have different objectives that are not always aligned, which may impact the execution of collaborative contracts. Strong policies in URIs towards IP – even unused IP – were also seen as barriers, as was a perceived lack of an overarching strategy in terms of governmental funding, with its different application systems and criteria which do not allow for synergies.

As a result of the data and insights collected, this report was produced, as well as a full academic report (available on request). Both reports detail recommendations to increase the quality and quantity of SME-URI collaborations in Australia.

Recommendations are organised into six themes:

1	Institutional funding and how access to, and sustainability of, funding could be organised
2	Individual and relational factors
3	The role of facilitators and how they can enhance SME-URI collaborations
4	Structural and behavioural changes within URIs
5	A focus on SMEs in general and high-tech SMEs specifically
6	The role of media and suggested improvements in communicating good examples of SME-URI collaborations

1 Introduction

Small and medium enterprises (SMEs) are the backbone of the Australian economy, as evidenced by metrics such as employment (44% of private-sector employment in selected industries), industry value added (34%) and gross domestic product (35%) from those SMEs employing fewer than 20 people. The Australian Bureau of Statistics (ABS, 2019) reports that nearly 44 per cent of businesses innovate, but that fewer than ten per cent collaborate with universities and/or research institutes (URIs). For SMEs, URI collaboration is slightly lower, and the Organisation for Economic Co-operation and Development (OECD) reports that Australian SMEs rank poorly for this type of collaboration (Mcdonald, 2017; World Bank, 2019).

There is a wide range of incentives for URIs to collaborate with industry, such as funding research programs and ranking objectives (e.g. through the Australian Research Council's Engagement and Impact exercise). Working with industry informs research agendas, funds research, and improves outcomes and impact (Ankrah & Omar, 2015). From a broader institutional perspective, there are greater expectations on URIs to play their role as an engine for economic growth through knowledge transfer from academic to commercial domains (Perkmann et al., 2013). SMEs, in turn, can use this knowledge to advance their innovation agendas and broaden their access to physical and intellectual resources at URIs.

Yet, anecdotal and empirical evidence shows these collaborations are infrequent and difficult to establish (OECD, 2019). Because SME-URI collaborations are particularly difficult to initiate and maintain, governments are frequently called on to serve as catalysts, thereby becoming the third helix in the so-called triple helix model of industry–government–URI collaboration (Etzkowitz & Leydesdorff, 2000; Mascarenhas, Ferreira, & Marques, 2018).

However, to direct government support for these collaborations more productively and sustainably, it is necessary to understand what constraints and enablers are present in the SME-URI ecosystem, the mechanisms that give rise to them, and also have good and reliable metrics to ensure a consistent evaluation of these collaborations. Furthermore, because of the multiple factors and multiple agents involved, it is important to develop a holistic and overarching analysis that all the agents involved can understand and use to work together.

This study investigates the nature, motivations, enablers, barriers and outcomes of SME-URI collaboration in Australia. This report is presented according to the four stages of RMIT's research design, commencing with a systematic review of the literature (Section 2), media analysis (Section 3), interviews and focus groups conducted with a range of stakeholders (Section 4) and survey data from 400 'collaborating' and 400 'non-collaborating' SMEs (Section 5). While interested in a range of Australian SMEs, the research team took a deep dive into high-tech industries, such as ag-tech and med-tech, expecting that those industries would be more likely to develop industry-URI collaborations (de Wit-de Vries, Dolfsma, van der Windt, & Gerkema, 2019; Skute, Zalewska-Kurek, Hatak, & de Weerd-Nederhof, 2019). The conclusion provides a set of evidence-based recommendations for SMEs, URIs and policy-makers (Section 6).

2 Background literature

SMEs account for approximately 90 per cent of all businesses globally and are construed as drivers of innovation, employment creation (Buganza, Colombo & Landoni, 2014), and economic development (Brink & Madsen, 2015). In Australia, SMEs make up more than 99 per cent of businesses (ABS, 2019). Contemporary literature points to a dearth in the number of SMEs using or collaborating with URIs (Fukugawa, 2013), particularly in Australia. In the OECD region, Australia has experienced a negative growth rate regarding measures of SME collaboration with URIs and now ranks lowest in the region (OECD, 2017, 2019).

Despite the importance of SMEs to socio-economic development, the perceived importance of external collaborations for SME success, and barriers to SME-URI collaboration, not much is known regarding these collaborations (Buganza et al., 2014). Most studies focus on collaborations between large organisations and URIs (Castrogiovanni, Domenech & Mas-Verdú, 2012) with minimal emphasis placed on SMEs. RMIT's study adopted a systematic literature review (SLR) approach. Following a rigorous scientific approach to reduce bias, emphasise transparency, and allow replicability, 98 articles were identified and reviewed.

Findings are categorised under five main thematic areas:

1	2	3	4	5
Motivation to engage in collaboration	Barriers to collaboration	Approaches to collaboration	Outcomes of collaboration	Enablers of collaborative success

2.1 Motivation to engage in collaboration

SMEs are likely to engage in collaborative initiatives when they perceive the derivative value of R&D, and information and knowledge spillovers generated from collaboration with URIs to be high. SMEs are highly motivated to collaborate with URIs when they have limited internal human capital, technological, R&D and knowledge capabilities in-house (Anderson, 1993; Asplund & Bengtsson, 2019). To bridge the chasm of resource endowment, SMEs, particularly new and small SMEs, are motivated to engage with URIs to gain knowledge pertaining to business, industry, technology or R&D (Biro et al., 2014; Cozza & Zanfei, 2016). Simultaneously, SMEs facing financial obstacles in developing or supporting their own R&D initiatives are highly motivated to initiate collaboration with URIs (Moraes Silva et al., 2020). The sector/industry in which the SME operates in is an integral factor greatly influencing their motivation for initiating collaboration with URIs. Particularly, SMEs operating in sectors where R&D and technical acumen are highly prioritised are motivated to collaborate with URIs (Fukugawa, 2016), for example, manufacturing, automotive, and electronics.

Motivation for collaboration among SMEs and URIs is also highly determined by the needs of the SME. SMEs may be motivated to engage and collaborate with URIs when there are public financial rewards to be attained, namely when governments provide subsidies to SMEs that collaborate with URIs. SMEs are also motivated to engage in collaboration when they seek to create strategic relationships with external parties (Asplund & Bengtsson, 2019). Particularly, when SMEs perceive that they can create long-term relationships for continued value creation, they were highly motivated to collaborate with URIs. Last, SMEs are driven to initiate collaboration with URIs when they seek to refine their product offering, improve the quality of their market offerings (Baggio et al., 2018), or enhance their R&D capabilities (Gabriele et al., 2017).

Unique to URIs, their collaboration with SMEs is highly motivated by the need of the university to engage in 'third mission' activities (Goduscheit & Knudsen, 2015). The third mission of universities seeks transformation from the basic objectives of teaching and research to a more entrepreneurial focus, characterised by commercialisation of research outputs and transforming into an entrepreneurial university (Schulze-Krogh & Calignano, 2019).

2.2 Barriers to collaboration

SMEs and URIs have different organisational cultures and approaches to business (Matlay, 2000; Puliga et al., 2019; Schulze-Krogh & Calignano, 2019). In other words, SMEs perceive that URI traditions and working environments are premised on more long-term approaches with flexible timelines to delivery. Whereas academics regard SMEs as being too rigid on timelines and too focused on quick results that may be unattainable (Karlsson et al., 2007). They also have different approaches and timelines in communication, which further hinders collaboration (Bjerregaard, 2009).

SMEs view academics as in pursuit of research outcomes of less interest to them, while academics are concerned that collaborations with SMEs do not yield important academic outputs (Goduscheit & Knudsen, 2015). Limited absorptive capacity within SMEs is also seen as a major barrier to collaboration between SMEs and URIs. Academics and SMEs view business size and newness as a significant barrier inhibiting SMEs' ability to utilise knowledge and R&D competencies stemming from collaborations (Merritt, 2015; Zajkowska, 2017).

Academics in URIs experience a lack of internal support as a strong barrier to collaborative initiatives with SMEs (Biro, 2015). Limited institutional support and uncertainty about the role of collaboration in career paths matters when competencies are evaluated through documented research or teaching experience, and to a limited extent SME collaboration (Karlsson et al., 2007).

SMEs have a lack of confidence in the ability of URIs to understand the day-to-day problems that they face or how to solve them. Further, the lack of contact with academics at URIs, as well as cost structures involved in collaboration activities, are seen to be highly prohibitive, particularly when SMEs are expected to fund initiatives (Dean, 1981; Puliga et al., 2019).

2.3 Approaches to collaboration

Both SMEs and URIs approach collaborations through the use of informal networks and personal contacts (Lindelöf & Löfsten, 2004; Cosh & Hughes, 2010; Biro et al., 2014; Pittayasophon & Intarakumnerd, 2017). Alternatively, collaboration between SMEs and URIs is developed through SMEs hiring academics/researchers as consultants (Fantino et al., 2015; Fukugawa, 2016; Jones & Corral de Zubielqui, 2017). SMEs also establish collaboration with URIs through the engagement of academics or postgraduate students as interns within their enterprises (Alunurm et al., 2020). Focusing solely on URIs, they might instigate collaboration with SMEs through setting up technology development centres that conduct R&D to meet specific needs of SMEs (Malik & Wei, 2011).

2.4 Outcomes of collaboration

SMEs that collaborate with URIs experience higher innovation and economic performance. By establishing links with academic researchers, SMEs are able to engage in product and process innovation, which in turn, positively influences revenue growth (Cattapan et al., 2012), access to new markets (Rosli et al., 2018), or higher profitability. Collaboration enhances SMEs' new-to-market innovation more than new-to-firm innovation (Hewitt-Dundas et al., 2019), product innovation (Motohashi 2008; D'Angelo & Baroncelli, 2020) and process innovation (van Hemert et al., 2013). However, the effects of innovation collaboration type varies by SME size. Particularly for micro enterprises, collaboration with URIs appears to have limited impact on product or enterprise innovation, but a more positive effect on process innovation (Parrilli & Radicic, 2020). As SMEs collaborate with URIs they gain in the short-term through problem-solving capabilities, knowledge access and R&D solutions (Xu, 2013), and gain long-term competencies of in-house staff (Oduro, 2019) through tacit and informal exchange of learning and knowledge (Linde, 1999; Bellini et al., 2019).

2.5 Enablers of collaborative success

For SMEs, the size (Triguero et al., 2015), age (Castrogiovanni et al., 2012), absorptive capacity, and strategic orientation (van Rijnsoever et al., 2017) of the enterprise are strong determinants of collaboration success. SMEs must possess a set of specific competencies to understand and exploit the outcomes of collaboration (Fantino et al., 2015). SMEs that are strategically oriented to create their own products/services/processes following a closed innovation strategy, are less likely to achieve success from collaborative initiatives than those following an open innovation strategy (van Rijnsoever et al., 2017).

Most unsuccessful collaborations between SMEs and publicly funded URIs are due to the perceived lack of trust from SMEs that the outcomes developed by academics will yield less valuable and appropriable outcomes (Matlay, 2000). Openness (Karlsson et al., 2007) and constant communication must be maintained to ensure trust (Kim & Park, 2015; Rosli et al., 2018). Also, collaborative agreements that are formalised with all terms specified within the agreement were more successful (Cloutier & Amara, 2018). Successful collaborations are enhanced by geographic proximity among the parties (Schulze-Krogh & Calignano, 2019).

2.6 Conclusion

The literature review discussed above focused on the motivations for R&D collaborations, the effects of collaboration, the determinants of collaboration success and the various approaches to collaboration (Figure 2). The results indicate that SMEs are highly motivated to collaborate with URIs when:

- they seek to access knowledge to solve technical problems
- they have limited internal R&D capabilities
- they operate in knowledge-intensive or high-tech sectors
- they seek to gain/utilise externally held R&D equipment.

Most common barriers to initiating collaboration between SMEs and URIs include:

- a lack of information
- financial costs
- lack of contacts
- differences in goals, cultures, and ways of operation.

SMEs and URIs can overcome these barriers through open communication, fostering trust, and establishing goal alignment. Collaboration with URIs can help to achieve higher R&D or innovation intensity and performance, new product development, cost reduction, higher revenue, and profitability.

Enablers
SME size
SME age
Absorptive capacity
Formalisation of relationship
Strategic goal alignment
Communication
Trust
Co-location

SMEs

Motivation

SME level
External
- Public sector funding
- Knowledge
- R&D equipment
- Strategic relationships
- Product testing and quality improvement

Internal
- Limited internal R&D
- Financial obstacles
- Perceived value
- Stage in lifecycle
- Sector of operation

URI level
3rd mission objective assimilation

Sector of operation

Barriers
Lack of information
Industry
Financial costs
Internal R&D intensity
Goal divergence
Contacts
Culture

Barriers
Goal divergence
Sector of operation
Contacts
Culture
Communication
Bureaucracy
Lack of 3rd mission incentives

Approaches
Social networks
Acquaintances
Consultancy
Internships
Research funding

Outcomes

SMEs
New knowledge
Patenting
Problem-solving
Innovative performance
R&D intensity
New product development
Internal production process
Profitability
New market development
Co-authorship
Journal publications

URIs
New research agendas/areas
Validation of research
Curricula changes

URIs

Figure 2: Categorisation of SME-URI collaborations

3 Media analysis

An analysis was undertaken of 92 Australian media articles published between 1988 and August 2020 exploring URI-SME collaboration. The search was designed to ensure that only articles including the term 'university collaboration' were returned. Thus, articles that referred to either 'university' or 'collaboration' in isolation were excluded.

Leximancer analysis produced five interrelated themes: the central group of references to 'universities' overlaps with each of the four surrounding themes of Australia, Business, Work and Students (Figure 3). Of these overlapping themes,

Australia, Business and Work interconnect quite closely, compared with Students, which only overlaps with Universities. This suggests that the discourse about university collaboration in the Australian media does involve work, business and universities, but that training students is seen as the core business for universities. Importantly, collaboration was seen as driven by business, rather than universities.

It was concluded that the media narrative does not highlight best practice and benefits of collaborations, which could be helpful in fostering greater collaboration between SMEs and URIs.
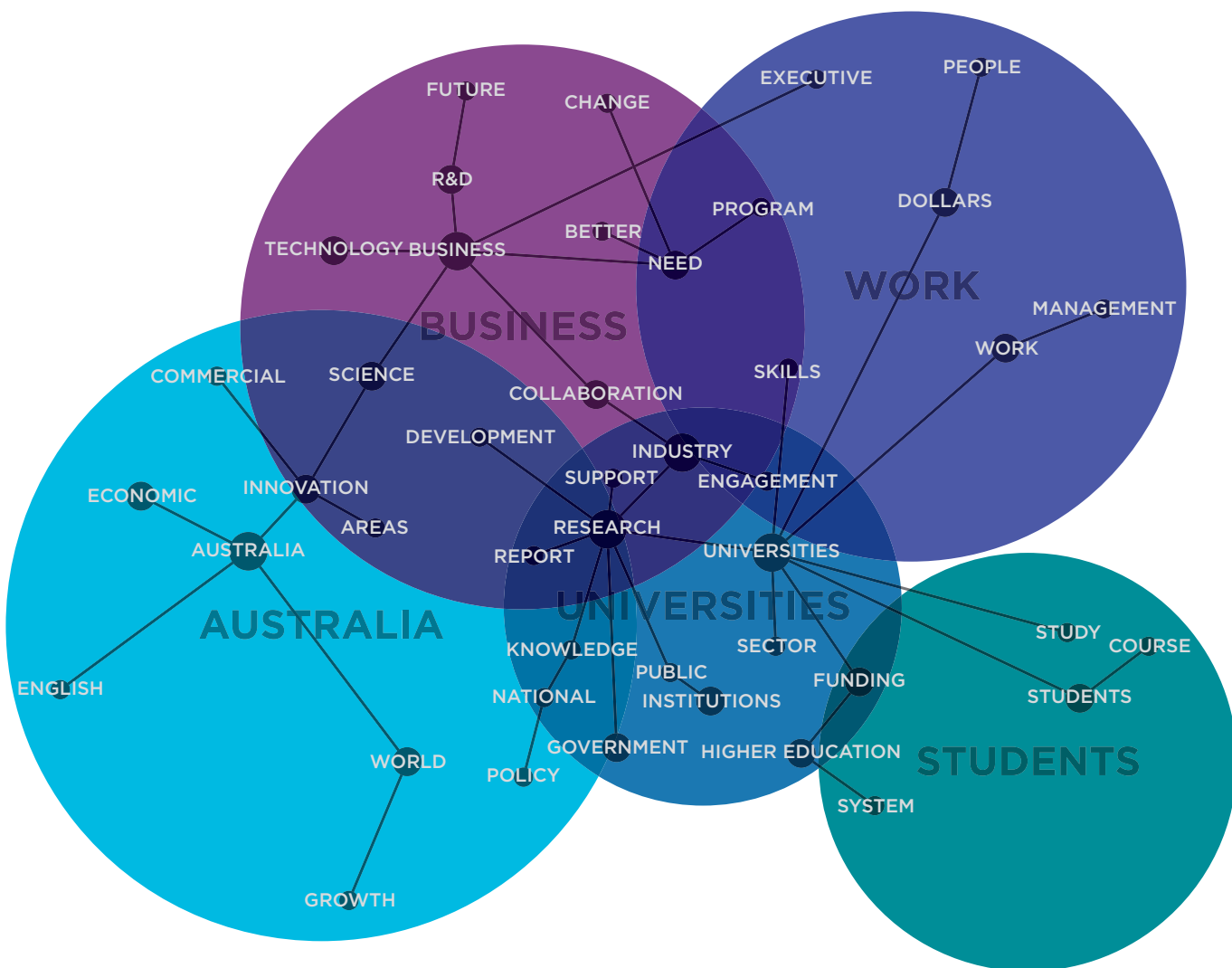
Figure 3: Leximancer map of media articles

4 Interviews

Interviews with stakeholders and participants in innovation-enabling programs were undertaken, to gain a holistic view of the SME-URI collaboration process and help inform our SME survey questions.

Twenty semi-structured interviews and three focus groups were conducted to uncover the antecedents and mechanisms that had supported or hindered collaboration through innovation-enabling programs:

7	interviews	SME owners/managers of collaborating firms
3	interviews	SME owners/managers of firms that had tried unsuccessfully to collaborate
3	interviews	CSIRO's Innovation Connections facilitators
3	focus groups	CSIRO's Innovation Connections facilitators
3	interviews	Researchers from URIs
4	interviews	Mid-, senior- and executive-level staff in URIs directly involved in innovation-enabling programs

4.1 Overview of findings

The SME participants engaged in innovation-enabling programs for one of three purposes:

- To develop a new product or service from scratch, bringing on board URI academics from the outset.
- Assistance in progressing an idea already under development within the firm. In this case, SME staff had reached an impasse and recognised that they needed additional expertise to continue the development.
- Gain validation for a product or service the firm had already developed by asking URI academics to review their innovation to ensure its legitimacy for market entry.

Analysis of the interview and focus group data yielded important information about the nature of SME-URI collaborations. The data showed factors that enable collaboration between SMEs and URIs, and those that hinder it. The data allowed identification of two overarching themes of enablers and barriers and to further categorise each of these into multiple sub-themes, for the development of a detailed picture of the factors involved in collaboration (Figure 4).

The top enablers of collaboration (80% of codes identified) were, in decreasing frequency:

- communication
- good relationships
- having a facilitator
- familiarity with collaborating
- matching business needs with research capability
- program funding
- having business staff with technical expertise.

The top barriers to collaboration (80% of codes identified) were, in decreasing frequency:

- complexity dealing with URIs
- mismatch of time focus
- limited funding
- not finding the right research capabilities
- uncertainty about the value of involvement.

Enablers

Good communication*

Good relationships and trust*

A facilitator*

Familiarity with collaborating*

Matched business needs and research capability*

Funding*

Business staff with technical expertise*

Clear expectations

Time focus

Setting up on case by case basis

Incentives for academics

Having a URI point of engagement

Supportive URI

Business staff open to collaboration

Existing relationship

Stakeholders identified

Researchers open to collaboration

Templates for agreements

+ Effective URI–SME collaboration **–**

Barriers

Complexity dealing with URIs*

Mismatch of time focus*

Limited funding*

Not finding right research capabilities*

Uncertainty about value of involvement*

Differing objectives

IP concerns

Value of URI not understood

Poor communication

Business is time poor

Legal complexities

Lawyer involvement

Previous bad collaboration

New to collaborating

SME technical people cautious of outsiders

Business set on one solution

Change in business management

Complexity of relationships

Program complexity

Different languages-business and research

Expectations

Poor relationships

Technical difficulty

Program restrictive

Bureaucracy

Initial mistrust

Scepticism

Regional bias in selecting unis

Limited knowledge of URI capabilities Australia wide

*80% of coding references

Figure 4: Enablers and barriers to URI – SME collaboration

4.2   Enablers and the role of facilitators

The interviews and focus groups highlighted a range of enabling factors present in successful collaborations. Both facilitators and SME staff relied heavily on their own personal networks for information and support in initiating and progressing collaborations. The importance of business staff having technical expertise for absorptive capacity, as identified in the literature, was also reflected in the data as an enabler. Previous collaboration experience also afforded SMEs the confidence to engage again with URIs.

An enabler not specifically identified in the literature, was the need for a good match between business needs and URI capability. This may reflect difficulties encountered in establishing this match, perhaps due to the geographical dispersion of URIs in Australia; difficulties in establishing physical contact; and temporal assumptions.

The enablers identified in this study reflect the prominence of practical aspects of collaborating:

- clearly defined people with whom to establish contact
- people on both sides to be open to collaborating
- government or URI funding
- presence of matchmakers/facilitators
- simple administrative processes.

Both URI and SME staff recognised the role of facilitators as key to collaboration success. Identified enabling benefits included:

- helping SMEs to identify their research needs
- providing information, namely funding opportunities
- connecting SME and URI staff
- guiding SMEs through administrative processes
- supporting communication and relationships
- clarifying IP concerns
- assisting with project management.

SME interviewees were very appreciative of facilitators' efforts, and on several occasions commented that the collaboration either would not have happened without them or that it would have taken much longer.

4.3   Barriers

Many barriers to collaboration identified in this study overlapped significantly with those identified in the literature (Figure 5).

Stakeholders at URIs highlighted that each collaboration funding scheme had a different submission system and lacked continuity. This lack of synergy introduced complexity and delays and meant firms and research teams were expected to re-write and re-submit similar projects several times. URI stakeholders also mentioned wanting to limit involvement with legal teams dealing with multiple projects, as these often resulted in significant time delays. Researchers suggested that high SME project overhead costs (itself a barrier) could be reduced by streamlining the contracting process through use of agreed templates.

IP ownership was often mentioned by interviewees. While some schemes allow IP to remain with the industry partner, data showed that it was often difficult for URIs to finalise contracts due to IP concerns. URIs had strong perceptions around new knowledge produced and its ownership, even if they did not use it in future. This may reflect a path-dependency in URIs' funding and the role of government subsidies towards URIs from the past. Further research is required to understand how much of the IP that URIs own is translated into value capture as important.

Participants noted difficulty in identifying the appropriate expertise needed for collaboration, which frequently required a multidisciplinary team. Furthermore, researchers identified a current lack of incentive for collaborations with SMEs. Researchers' KPIs and incentives focus on large-scale and Category 1 and 2 grants, with little incentive for them to carry out applied research involving SMEs.

The difficulty of finding the appropriate research capability was identified by both facilitators and SMEs. Firms' limited knowledge of URI capabilities Australia-wide could be exacerbated by facilitators' accountability for regions and the importance assigned to physical proximity, whereby facilitators may be more familiar with local URIs and perhaps not aware of more suitable capabilities elsewhere in Australia.

Barriers identified specifically by SMEs included: being unfamiliar with university research and uncertain about the value of research; SME staff being cautious about outsider involvement and less open to other possible solutions; previous bad collaboration experiences; and general mistrust and scepticism of URIs.

Furthermore, SMEs noted a number of problems that are transversal to their industry and require other industry partners. However, many available funding schemes are not open to multi-partner collaborations.

It should be noted that, in general, SMEs were very positive about their experiences, suggesting that participants believed that the benefits they gained outweighed any difficulties experienced.

4.4   The collaboration process

To explore how these enablers and barriers influenced collaboration progression, key groups of activities were identified using data collected from the interviews. Each activity group was assigned a 'process descriptor' within the overall collaboration process. It is not intended that the combination of these process descriptors describe the overall engagement process, rather, how these activity groupings correlate with the collaboration enablers and barriers identified to generate insights as to how the collaboration process may be enhanced.

Each enabler and barrier was mapped to these collaboration process 'stages' (Figure 6), and interviewees were asked what conditions needed to be in place for the collaboration to progress at each of these stages. These identified conditions were used as a basis from which to develop RMIT's recommendations. These conditions include:

- institutional or URI funding
- SME staff with technical expertise
- stakeholder awareness of URI capabilities
- navigable, flexible programs
- facilitators
- encouragement and support for researchers/academics to engage with SMEs
- streamlined legal processes
- a streamlined way of matching SME needs with URI capabilities
- access to the most suitable researchers/academics.

The results from the interviews, background data (discussed in the long form report) and the literature review were used to design the survey questions. These findings are presented in the following section.

	Interviews		Literature
Enablers	• **Matched business needs and research capability** • Setting up on case by case basis • Stakeholders identified • Business staff open to collaboration • Research staff open to collaboration • Templates for agreements	• **Good communication** • **A facilitator** • **Familiarity with collaborating** • **Trust** • **Funding** • **Business staff with technical expertise** • Adequate resources • URI has readily accessible business liaison staff • Top level support • Incentives • R&D valued • Geographic proximity • Cross-sector similarity	• Good project management • Business stability • Multiple other business-RI channels (e.g. consulting, internships) • Teamwork and flexibility • Technology-based sector • Desire for long term relationship • Well-specified collaborative agreements • Business environment • Objectives well-aligned
Barriers	• **Not finding the right research capability** • New to collaborating • SME technical people cautious of outsiders • Business set on one solution • Complexity of relationships • Change in business management • Previous bad collaboration Bureaucracy • Initial mistrust • Scepticism • Regional bias in selecting URIs • Limited knowledge of URI capabilities Australia wide	• **Mismatch of time focus** • **Uncertainty about value of involvement** • **Limited funding** • **Complexity dealing with URIs** • Cross-sector differences • Poor communication • Different objectives • URI capability not understood • Lack of URI business liaison staff • Technical difficulty of the project • IP concerns • Complexity of legal process • Complexity of managing the collaboration process • Program restrictive • Rules and regulations restrictive	• Perception that URIs only do pure science • Lack of absorptive capacity • Overselling of URI capabilities • Lack of interest by URI researchers • Lack of publishing opportunities • Academic career paths • Academics' not understanding business problems • Lack of academic contacts • Lack of trust • Lack of information

Bold text denotes: top 80% of coding references.

Figure 5: Comparison of enablers and barriers between interviews and literature

Figure 6: Mapping the enablers and barriers identified to the process stages

Process descriptor	Enablers	Barriers	Good communication | Good relationships and trust | Facilitator	Poor communication | Poor relationships | Different languages-business and research	For the collaboration to progress, the following elements need to be in place:	Facilitator
Initial contact	Familiarity with collaborating Funding Business staff open to collaboration Existing relationship Business staff with technical expertise	Limited funding Uncertainty about value of involvement Value of URI not understood New to collaborating Previous bad collaboration SME technical people cautious of outsiders Program complexity Program restrictive Bureaucracy Not finding right research capabilities Regional bias in selecting URIs Limited knowledge of URI capabilities Australia wide			Funding Business staff with technical expertise Awareness of URI capabilities Navigable, flexible program	
Identification of required capabilities	A facilitator				Facilitator	
Location of suitable RI capabilities	Matched business needs and research capability Having a URI point of engagement Researchers open to collaboration Incentives for academics	Not finding right research capabilities			Encouragement for researchers to engage with SMEs Streamlined way of matching SME needs with URIs capabilities Ease of access to right academic	
Initial meeting	Clear expectations	Initial mistrust				
Agreement groundwork	Stakeholders identified Setting up on case by case basis	Scepticism			Streamlined legal processes	
Project agreement	Templates for agreements	Complexity dealing with URIs Complexity of relationships Differing objectives IP concerns Legal complexities Lawyer involvement				
Project pre-approvals					URIs support for academics	
Project execution	Time focus Supportive URI	Mismatch of time focus Business is time poor Business set on one solution Change in business management Technical difficulty Expectations				

CASE STUDY
UAP

UAP, a high value bespoke art manufacturer, was searching globally for an R&D partner to help transform them from a traditional manufacturer to an advanced manufacturer. They were able to find the robotics and design capability they needed, here in Australia, at Queensland University of Technology (QUT) and the Royal Melbourne Institute of Technology (RMIT).

UAP needed its digital transformation opportunities assessed by its new collaborators and a $50k dollar-matched Innovation Connections grant allowed them to engage two designers for a period of four months. As the relationship between the universities and UAP grew, UAP built a business case and submitted a five-year $8M project application, Design Robotics, to the Innovative Manufacturing CRC.

The successful grant outcome would lead to the creation of the Advanced Robotics for Manufacturing Hub (ARM Hub). The Design Robotics project led to other SMEs engaging and accessing the technology and expertise offered by UAP and at the ARM Hub. Industry demand was so substantial that the Hub was able to raise $18M from government, research and industry stakeholders and has since raised an additional $29M investment in its first nine months of operations. The Hub has now engaged over 190 companies, conducted over 80 site visits and business referrals and is currently working on 70 projects.

Matthew Tobin, Managing Director UAP, said "the key for our R&D success was embedding the research expertise in the business, playing an active role in translating the new knowledge and capability developed into commercial opportunities."

"Embarking on Design Robotics also gave UAP management and staff a mandate to undergo digital transformation, which flourished well beyond the research project itself, into areas of augmented and virtual reality, for example."

For UAP, the project outcomes resulted in an upskilled workforce, on-shored manufacturing to Australia, and a strong value proposition to a global marketplace.

ARM Hub CEO Associate Professor Cori Stewart said "supporting SMEs is so important for our nation's industrial transformation, yet so hard because these businesses are so busy. There is risk for investors because business priorities may change, and R&D is likely to be undertaken on products or services that are also the business' day-to-day commercial reality". She said what is needed is "institutional support where businesses can access trusted innovation advice and capability". "Skilled facilitation of opportunities is critical, as is building a collaborative ecosystem where business can do bigger business together".

CASE STUDY
Sleeptite

Sleeptite exists to improve the health and wellbeing of older Australians through innovative and technologically advanced bedroom solutions. CEO and founder, Cameron van den Dungen wanted to create Smart Bedding that provides biometric analysis of a person's movements and vital signs to their carers through the night – allowing for non-invasive monitoring, as well as a good night's sleep.

After an industry advisor facilitated a meeting with RMIT University's Professor Madhu Bhaskaran, her award-winning stretchable sensor technology was considered as the basis for Smart Bedding. Sleeptite then engaged mattress manufacturer, Sleepeezee Bedding Australia, to translate RMIT's research into a scalable manufacturing process, and in July 2018, a joint Cooperative Research Centres – Project (CRC-P) bid for the Sleeptite project was successful.

The Sleeptite project started with a clear end goal in mind, however the path to that goal kept changing. Collaborators had different expectations of timelines, struggled to understand each other's technical languages and work processes. There were many 'firsts' for team members and in some instances the learning curve was quite steep. The researchers had limited experience with large-scale manufacturing, the manufacturers had never worked with researchers before and the Sleeptite office entered the collaboration without any pre-existing technical knowledge in engineering, science or R&D.

Professor Sharath Sriram and Sleeptite CEO Cameron van den Dungen examining flexible sensors in RMIT's Micro Nano Research Facility.

It became clear to industry partners, R&D is a time-consuming, methodical process of designing, testing, trialling, refining, and re-designing until reaching the desired outcome. The researchers found that industry expected short turnarounds and were constantly pushing for minimisation of costs and maximisation of profit.

Key to overcoming these barriers was communication. Sleeptite CEO Cameron van den Dungen believed that communicating and finding a common ground was key and created a culture of openness and transparency. This helped the diverse, multidisciplinary team overcome challenges, and subsequently benefit from diversity of thought.

Through learning by doing, the Sleeptite CRC-P became a successful collaborative project between industry experts, micro- and nano-technology engineers, data architects and bedding manufacturers. This cross-sector collaboration has created valuable technology that will better the lives of Australia's elderly.

The Sleeptite CRC-P is currently in its final year of funding and is preparing its Smart Bedding system for extensive field trials. The collaboration is on track to surpass all project milestones and additional work was undertaken to ensure that the technological platform could also be used as a sleep validation tool. Market extensions into neo-natal care, home care and correctional facilities are planned for future growth.

5 Survey

This section summarises the results of the telephone survey of the managers/owners of 400 known, collaborating SMEs and 400 randomly selected, non-collaborating SMEs, conducted between 14 August and 14 October 2020. Interviews were conducted by a high-quality computer-aided telephone interviewing (CATI) provider, Ipsos, that uses highly skilled interviewing staff. As a result, the response rate for collaborating firms was 78 per cent, with the average interview lasting 26.8 minutes. To survey non-collaborating firms, a database was purchased from an approved ASIC provider. The response rate for these firms was 30 per cent and the average interview, based on a shorter survey, lasted 18.2 minutes.

5.1 Demographics

The surveyed firms exhibited the following demographics:

- Size: firms that did not collaborate were significantly smaller than those that collaborated. The mean number of employees among non-collaborators was 15.9 (standard deviation (SD) of 22.8) and 28.4 (SD 35.4) for collaborators.
- Age: There was little difference in the mean firm ages of non-collaborators and collaborators.

- Industry: Collaborating firms were more prevalent than non-collaborators in the following industries: manufacturing (27.8% vs 17%), professional, scientific and technical services (8.6% vs 5.5%), agriculture (13.8% vs 7.5%), mining (7.0% vs 2.5%) and healthcare and social assistance (7.3% vs 3%). Non-collaborators were strongly represented in retail trade (11.3% vs 1.8%), accommodation and food services (11.5% vs 2.5%), and finance and insurance services (6.3% vs 2.0%).
- Selected industry categories: Among industry sectors, collaborating businesses were strongly represented across mining (73.7% of respondents in this industry sector were collaborators), healthcare (70.7%), agriculture (64.7%), and professional services and education (63.4%). Non-collaborating businesses were strongly represented in trade (76.8%), other services (75.0%) and construction (55.7%) (see Figure 7).
- Performance: 29.6 per cent of non-collaborating firms had a turnover of at least $5 million, which was significantly lower than 44.8 per cent of collaborators.
- Qualifications: Respondents among the collaborators had a higher mean level of educational attainment than respondents from non-collaborators (see Figure 8).
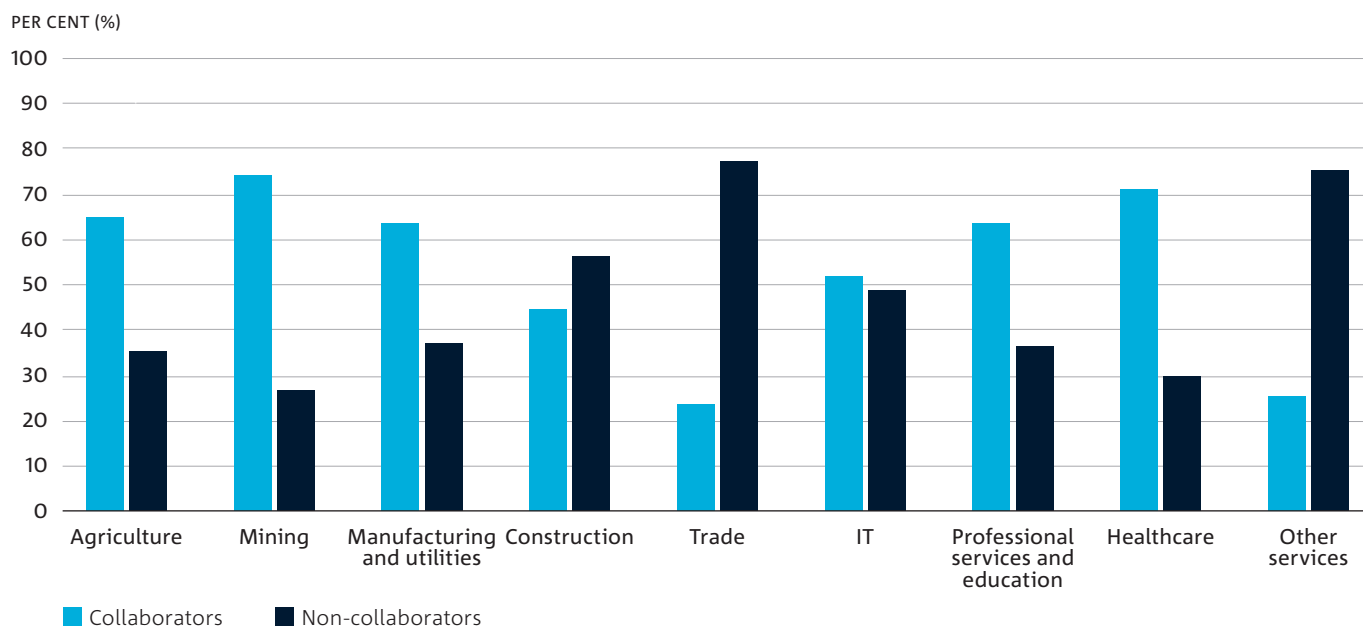
PER CENT (%)

Figure 7: Survey respondents by selected industry sector
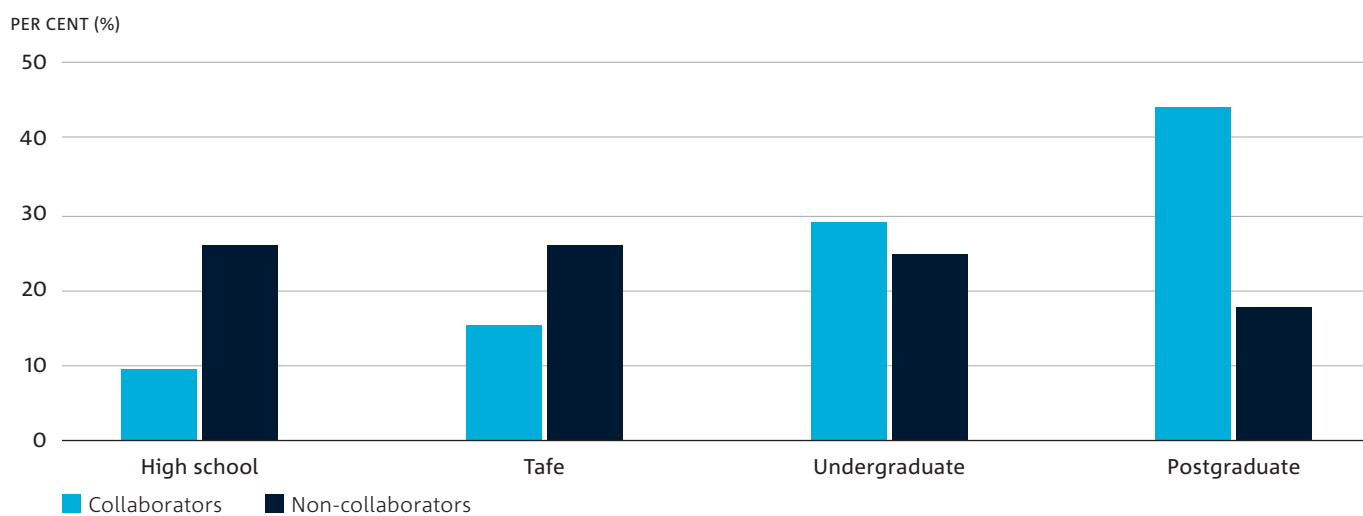
PER CENT (%)

Figure 8: Survey respondents and educational attainment

5.2 What does collaboration with URIs mean to SMEs?

In an open ended question, participants commented that, for them, collaboration involved:

- knowledge transfer
- exchange of skills and experience
- accessing expertise, facilities and resources that they were not able to otherwise access.

They also indicated that collaboration involved investment by both parties and that benefits flowed both ways, as increased capability to their firms, and as exposure to the real world for URI students. Participants then expressed the purpose of collaboration in terms of:

- fixing a problem
- growing their business
- discovering useful, previously unknown knowledge
- developing new products and services
- creating IP
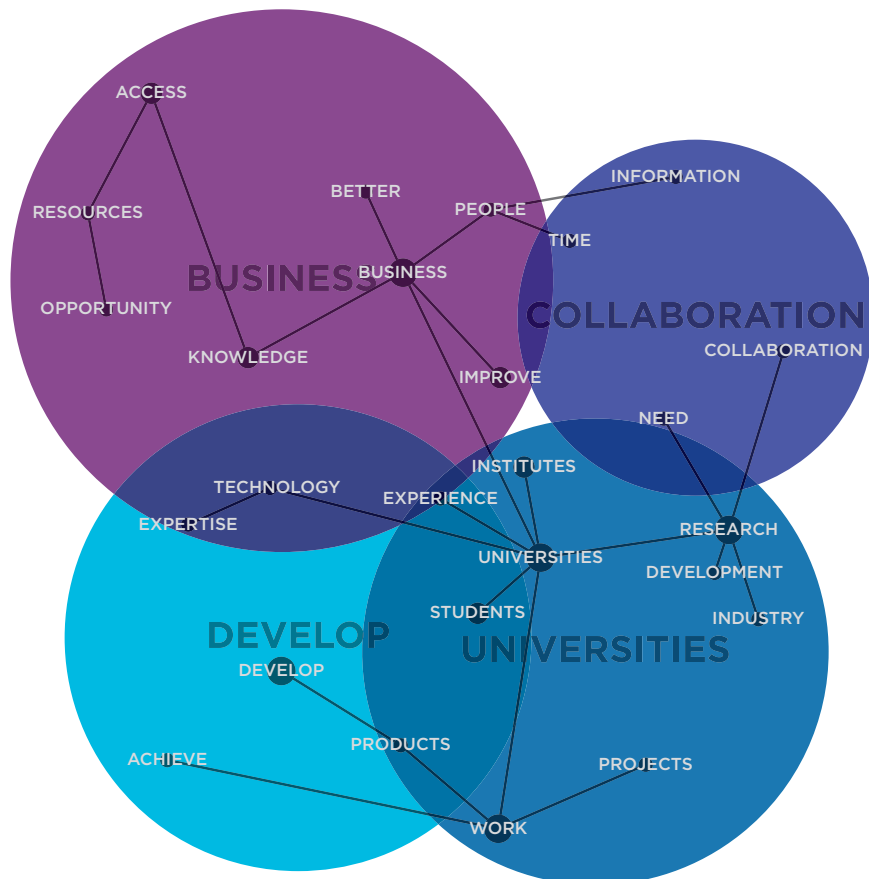- innovating in order to gain competitive advantage and grow their business.

Figure 9: Leximancer map of definition of collaboration (collaborators only)

Responses from non-collaborators were significantly different from those of collaborating participants. While collaborators were able to give quite detailed explanations of what collaboration meant for them, just over one-quarter of non-collaborating participants responded that they did not know what collaboration was. These respondents indicated that collaboration was not a priority for them and so were not concerned that they did not understand it. Interestingly, many participants misunderstood collaboration and saw it as helping researchers by providing information to help them with their research problems, rather than as an opportunity to support their business.

This latter observation leads us to suggest that these respondents may not collaborate because they have an incorrect understanding of what collaboration entails, and that a better understanding of collaboration may render them more open to considering collaboration with URIs.

The dramatic difference in responses between collaborators and non-collaborators is reflected in the themes and sub-themes generated using Leximancer (Figures 9 and 10).
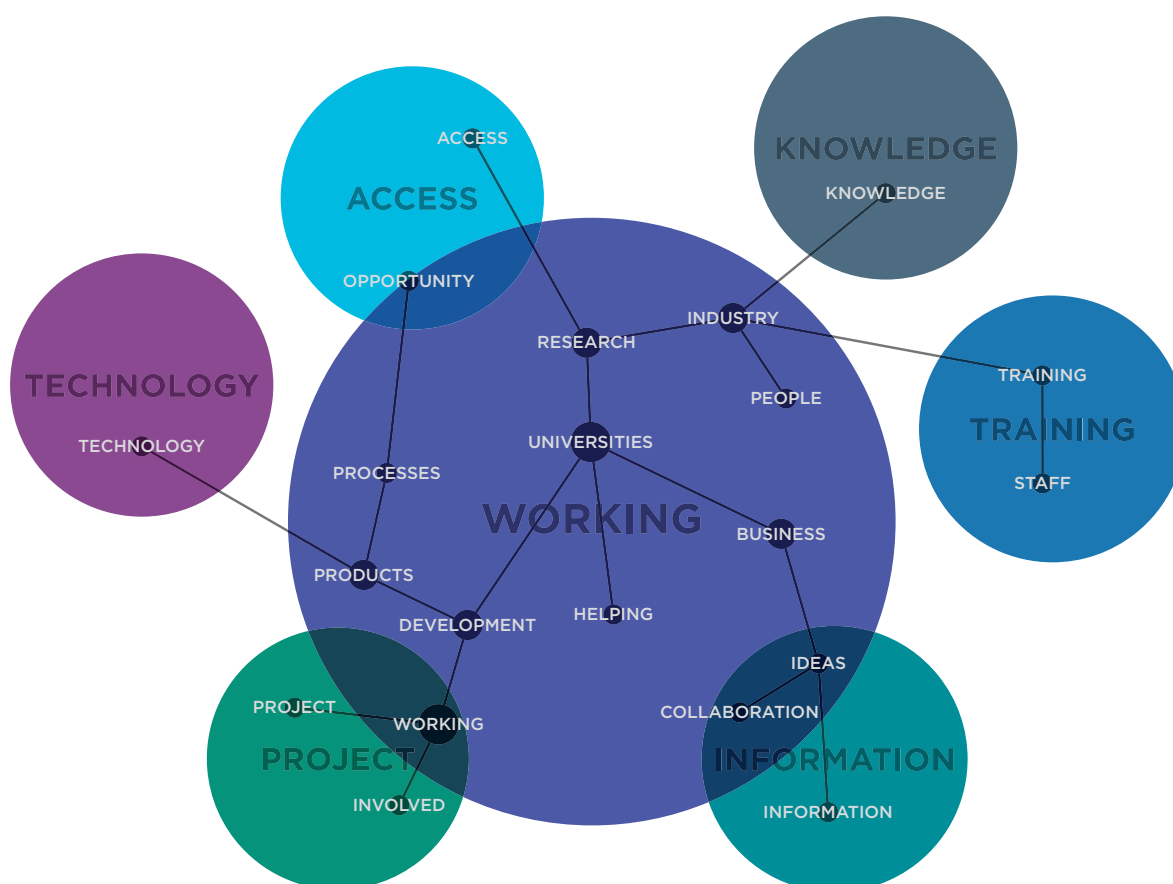

Figure 10: Leximancer map of the definition of collaboration (non-collaborators only)

5.3   Type of collaborative activity

Collaborators were provided with a list of typical collaborative activities that SMEs and URIs undertake, based on our review of the literature and interviews described earlier.

As seen in Figure 11, the most commonly reported collaborative activities were joint research projects funded by business (66.9% of respondents, SD 47.1%), recruitment of recent graduates (48.4%, SD 50.0%) and joint research projects funded by the business and a university (44.3%, SD 49.7%). The two least cited collaborative activities were staff training or placements into research institutes (12.8%, SD 33.4%) and university and research advisory board roles (14.3%, SD 35.0%).

There was a positive relationship between collaborative activities and firm size; larger firms were more likely to engage in collaboration (see Figure 12). There was no clear pattern between firm age and collaborative activities.

Collaborating SMEs (see Figure 13) in the mining industry sector reported the highest levels of collaborative activity across all categories (mean 47%), particularly with respect to joint research projects funded by the business (85.7%) and participation in fairs, seminars, workshops or other public forums (75.0%). Collaborating businesses in manufacturing and utilities reported the lowest mean across all collaborative activities (38.1%), in part reflecting low responses for URI/research advisory board/university committee roles (11.9%) and staff training or placements (5.6%).

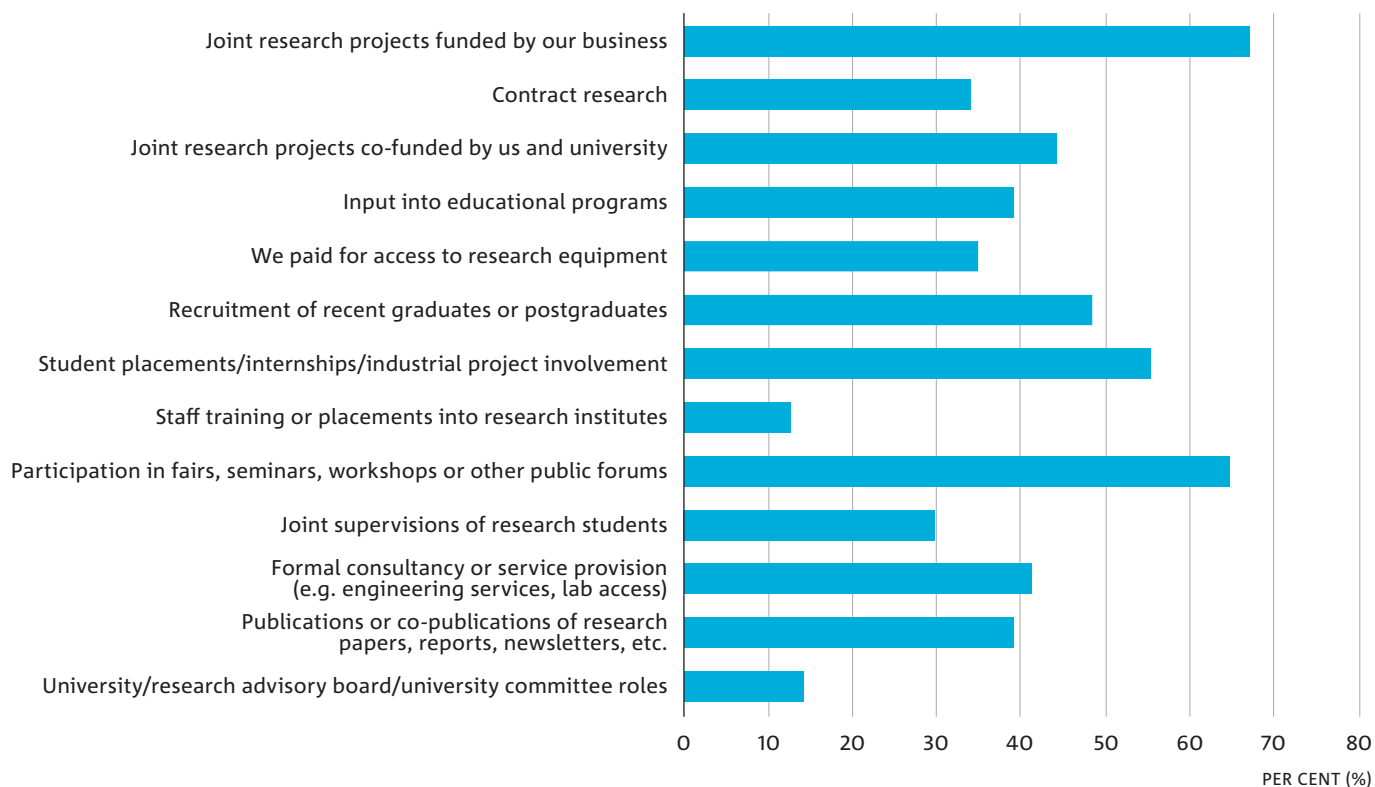Figure 11: Type of collaborative activities undertaken (collaborators)

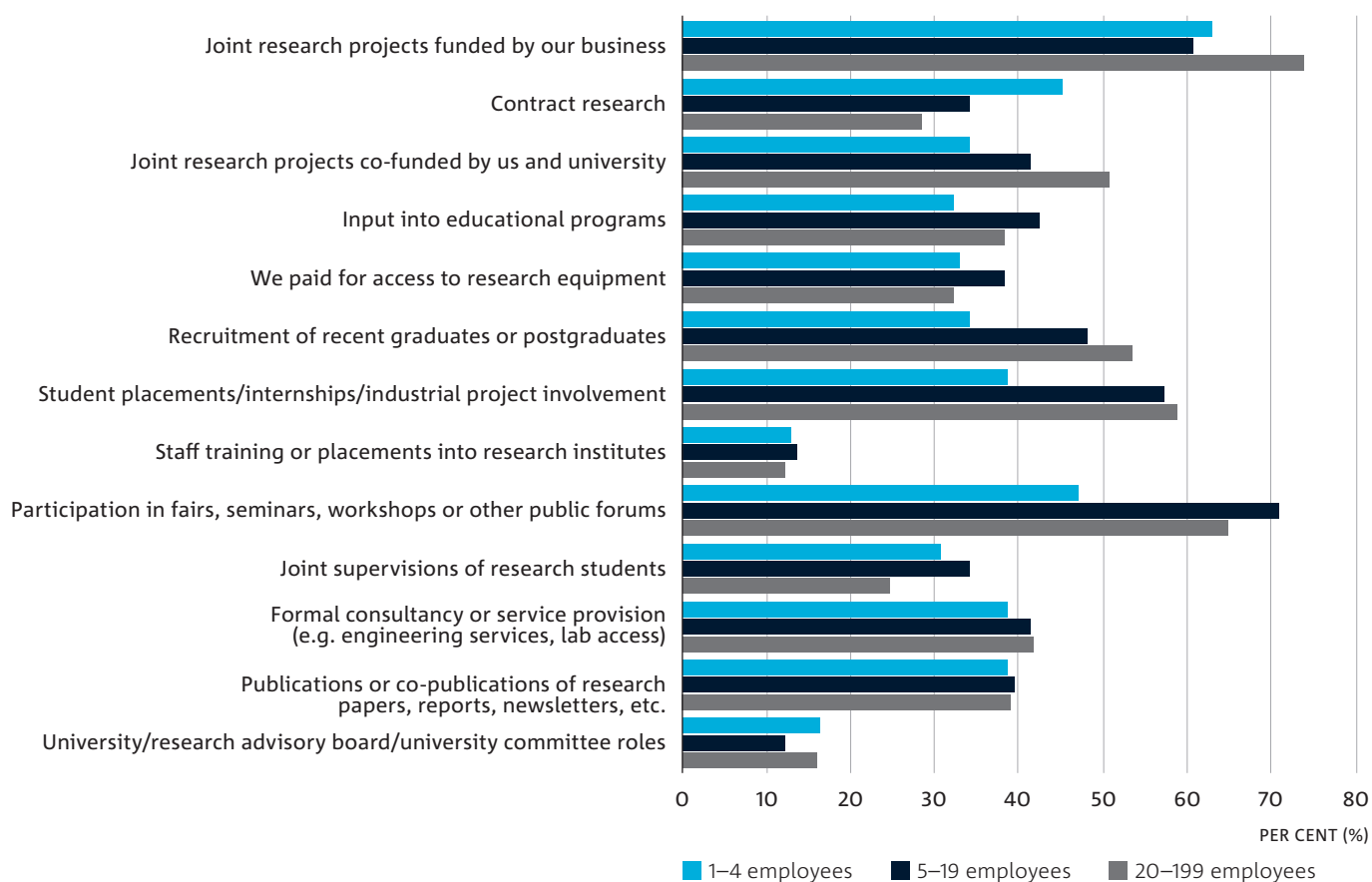1–4 employees   5–19 employees   20–199 employees

Figure 12: Type of collaborative activities undertaken by firm size (collaborators)
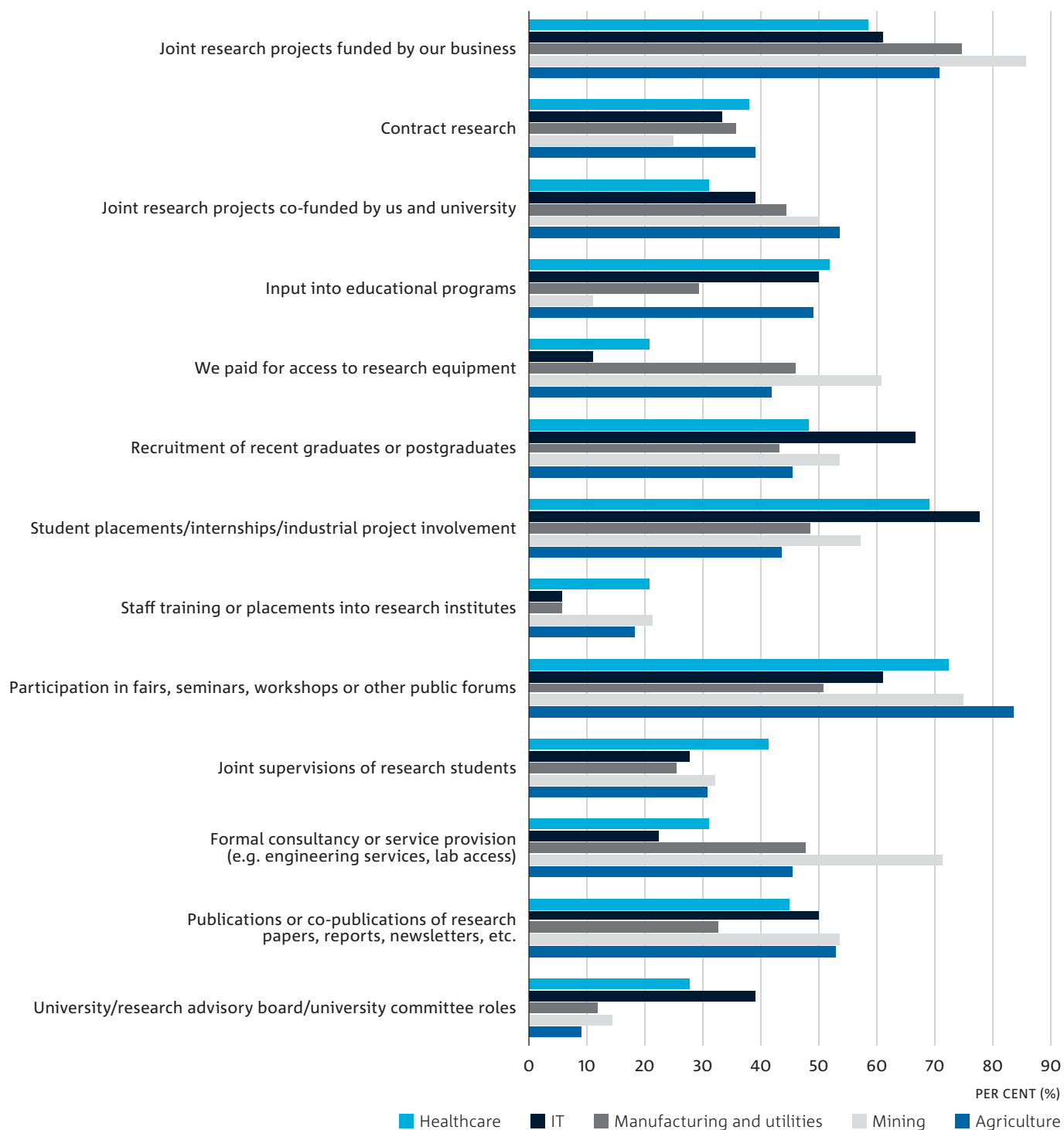
Figure 13: Collaboration activities and industry (collaborators)

Collaborative activities were distinguished between research versus training-focused, based on factor analysis of 1–5 point Likert scale questions. The research-focused collaboration factor was constructed from three activities:

- joint research projects funded by the business
- paid for access to research equipment
- formal consultancy or service provision.

SMEs that had a high loading on this factor were classified as engaging in more mature, research-focused collaborations. The training-focused collaboration factor was constructed from five activities:

- input into educational programs
- recruitment of recent graduates
- student placements/internships
- joint supervisions of research students
- URI advisory board roles.

The results found that micro firms tended to be more research- than training-focused. In contrast, larger SMEs were more focused on training-activities, pointing to a greater ability to do in-house research (Figure 14).

When comparing different age categories (Figure 15), it was observed that younger businesses were more focused on research activities as compared with older businesses that were more training focused.

Among industry categories (Figure 16), training-focused activities were highest in the provision of services, particularly for immature collaborative activities: IT (mean 2.6), healthcare (2.4), professional services and education (2.2), and other services (1.9). The businesses engaging in research-focused activities were highest in mining (2.5), manufacturing and utilities (1.9), and agriculture (1.9).
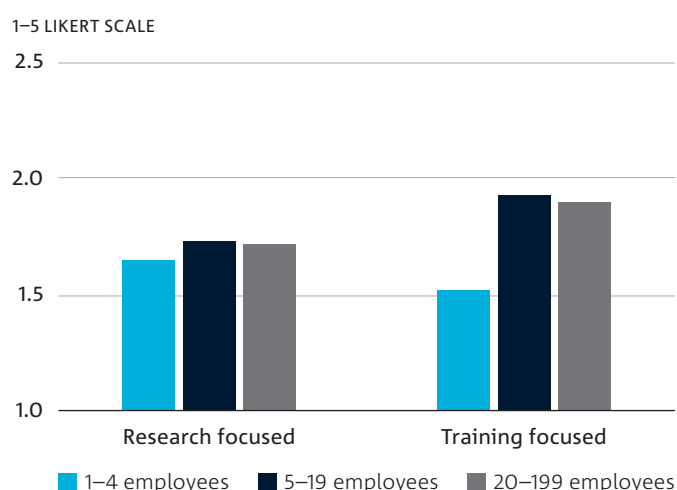
1–5 LIKERT SCALE
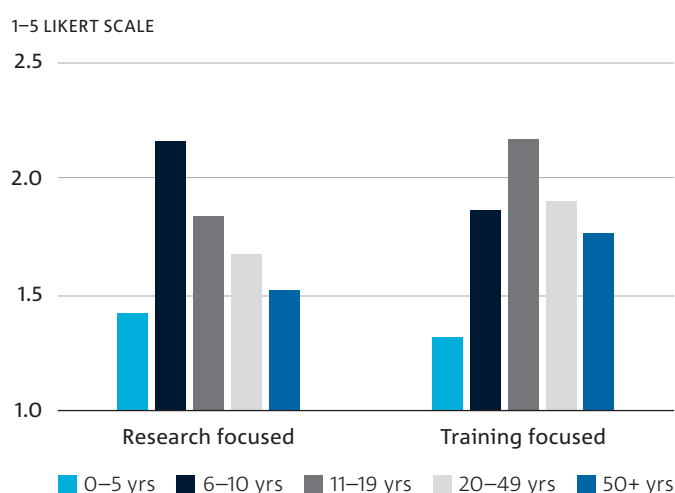

Figure 14: Collaboration maturity and firm size

1–5 LIKERT SCALE

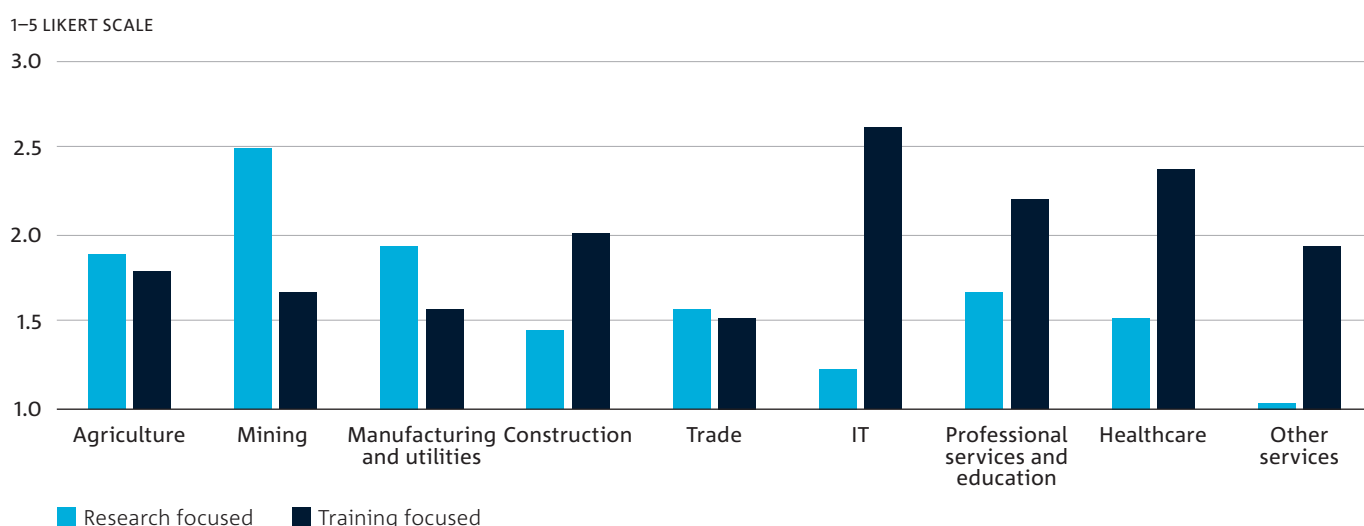Figure 15: Collaboration maturity and firm age

1–5 LIKERT SCALE

Figure 16: Collaboration maturity and industry

5.4 Collaboration enablers

Both collaborating and non-collaborating SMEs were asked to indicate from a list collaboration enablers (yes/no/n.a.) which were relevant to, or have been experienced within, their business. The four most widely reported collaboration enablers included cost-effectiveness (45.6% of respondents), matching academic and industrial goals (35.0%), navigating the research partner's internal structures and processes (33.8%) and having adequate internal resources (33.1%). The enablers that received the lowest responses for both groups were having an existing relationship with your research partner (4.1%), mutual trust (5.5%) and having a collaboration champion (6.3%). (See Figure 17.)

The largest differences between the two groups were across six enablers: the match between academic rigour and industrial relevance (47% of collaborator respondents vs. 23% of non-collaborators), the ability to navigate the internal structures of partner organisations (45% vs. 23%), cost-effectiveness (56% vs. 35%),

delivery time frames (35% vs. 18%), internal resources to facilitate collaboration (41% vs. 25%) and appropriate expertise in the partner organisation (35% vs. 22%).

Agricultural collaborating businesses reported higher average levels of collaboration enablers (mean 28.2%), particularly regarding cost (72.9%), navigating the partner research organisation's internal structures (58.3%) and adequate internal resources in your business to facilitate collaboration (54.2%) (Figure 18). Collaborators within mining scored the enablers the lowest, notably existing relationships with partner research organisation staff (0%) and presence of a collaboration champion with the partner research organisation (3.6%).

It is noteworthy that the industry sector with the most negative overall view of enablers among non-collaborating businesses was agriculture, with a mean response across all categories of 11.2 per cent. Non-collaborators that scored enablers strongly were located in healthcare (19.6%) and mining (19%).
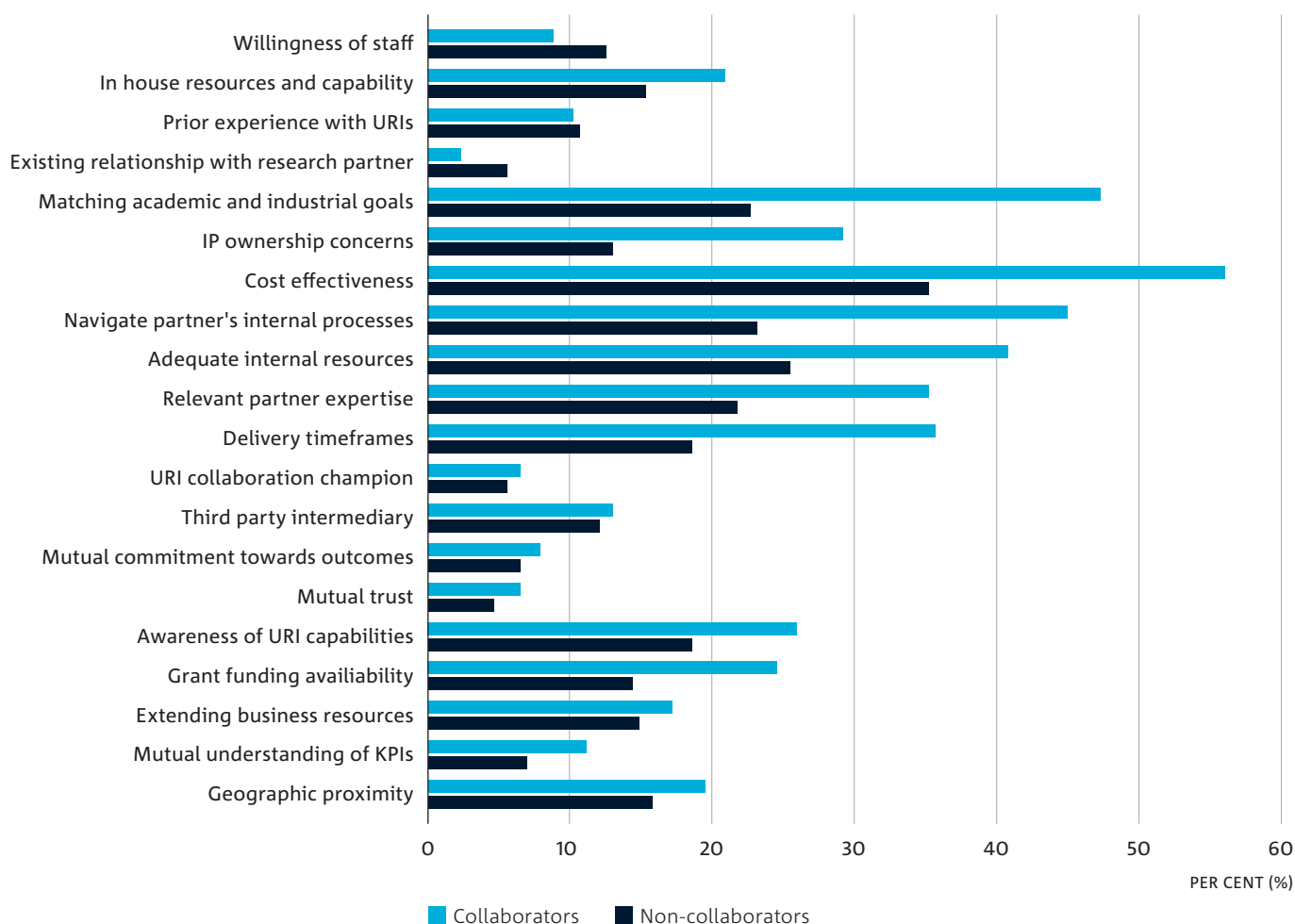
Figure 17: Collaboration enablers
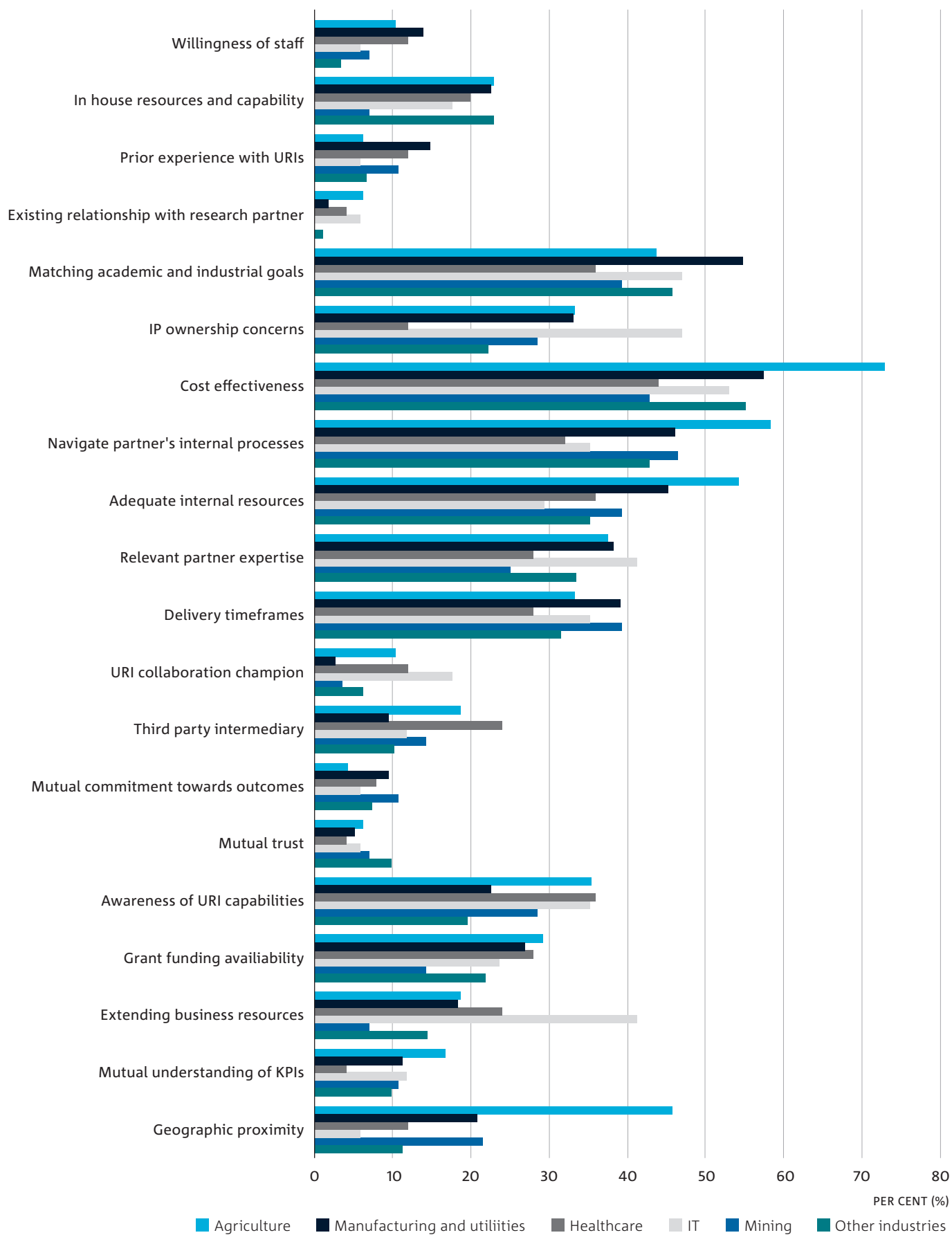
Figure 18: Collaboration enablers and industry – collaborators

5.5   Collaboration barriers

Respondents were provided with a list of potential barriers to collaboration, based on the previous stages of this study (Figure 19). For the entire sample, the four most widely reported collaboration barriers were lack of mutual trust (57.4% of respondents, SD 68.6%), mutual commitment to successful outcomes (55.5%), staff willingness (53.8%) and lack of a collaboration champion or facilitator (53.1%). SMEs that collaborated with URIs generally rated barriers higher than non-collaborators, most likely due to their first-hand experience with the issues. The largest differences between the two groups appeared across four barriers: a lack of previous experience with URIs (62% collaborator verses 16% non-collaborators), lack of an existing relationship with

the research partner organisation (70% vs. 30%), mutual commitment to collaboration outcomes (71% vs. 40%) and the lack of a URI collaboration champion within the partner organisation (67% vs. 39%). Two of the most commonly cited barriers by collaborators were mutual commitment to collaboration outcomes (70.7%) and mutual trust (67.2%), while 47 per cent of non-collaborators cited mutual trust and 41.8 per cent cited mutual understanding about the KPIs.

It is noteworthy that both collaborators and non-collaborators were more likely to score barriers higher than enablers.
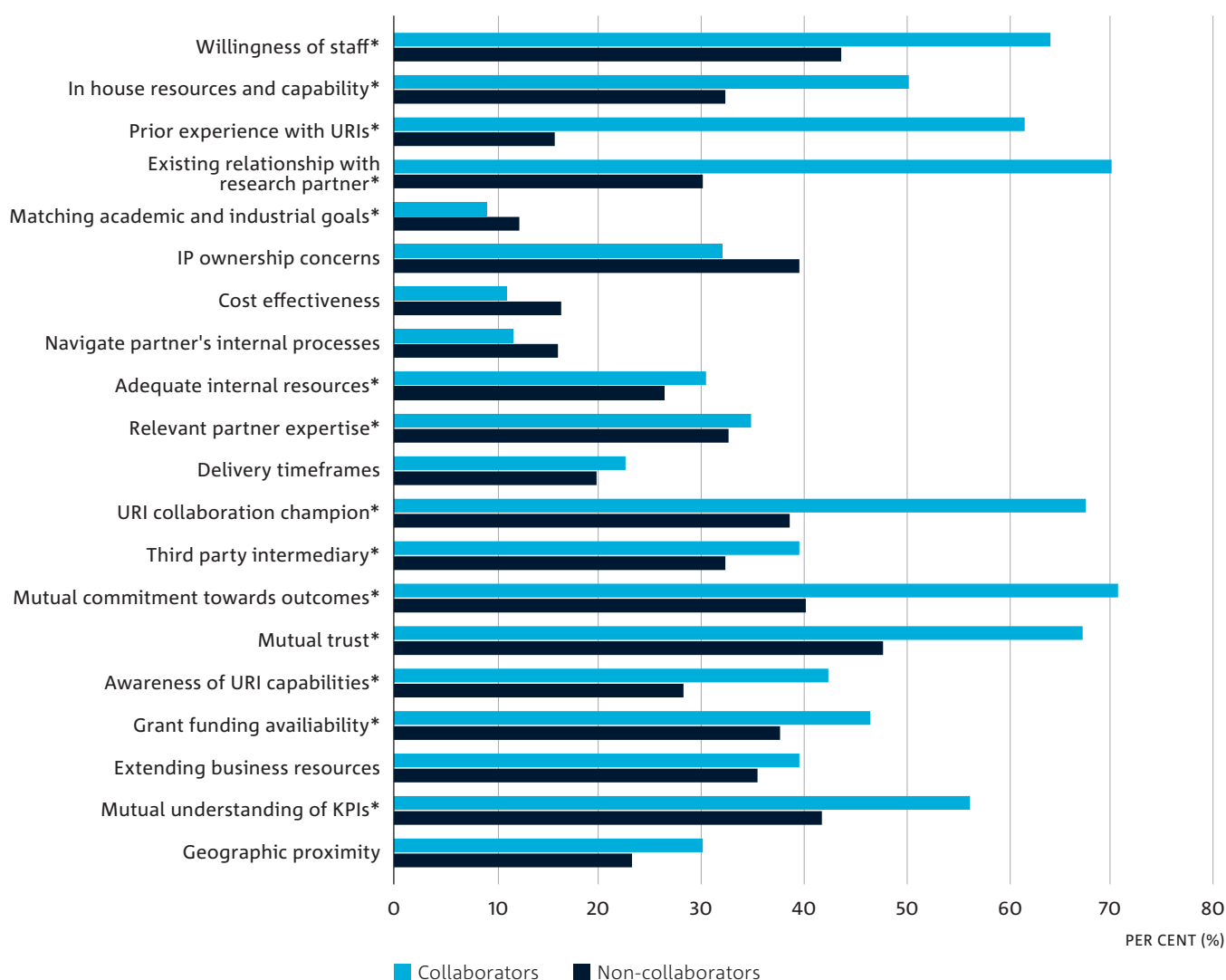
Figure 19: Collaboration barriers (*indicates 'lack of')

5.6 Comparing collaboration enablers and barriers

Among collaborators (Figure 20), relational factors received the highest net barrier score for collaboration; these included mutual trust, mutual commitment, and the lack of a collaboration champion or an existing relationship with the research partner.

The highest net enabler scores for collaborators were cost effectiveness, matching academic and industrial goals, and navigating a partner's internal processes. Non-collaborators also interpreted relational factors as the key barriers to collaborative activity.

Overall, the net barrier and enabler scores across collaborators and non-collaborators suggest that the strength of the relationship, mutual understanding and trust between partners can help to lower SMEs' perceived risks when considering engaging in collaborative activity with a URI.
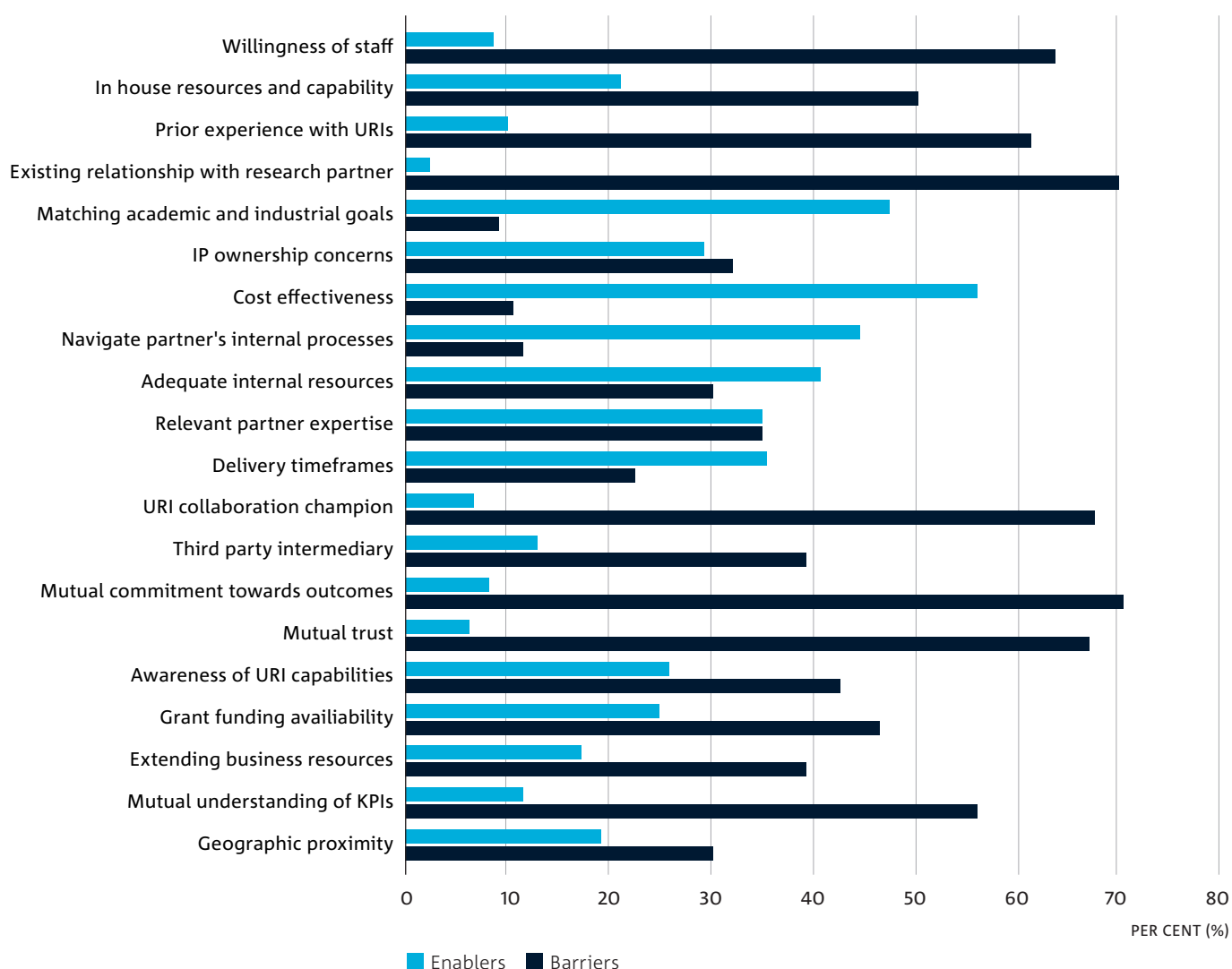
Figure 20: Collaboration enablers and barriers (collaborators)

5.7   High-tech industries and collaboration enablers and barriers

SMEs that were part of the agricultural, mining or health industries, were asked a follow-up question to ascertain whether they could be classified as food-tech, ag-tech, mining-tech, pharma or med-tech. Ag-tech businesses scored collaboration enablers highly, with a mean percentage of 26.5 per cent across each category, with cost (60%) and adequate internal resources in the business

to facilitate collaboration (60%) representing the most widely cited enablers (Figure 21). The small sample size of ag-tech businesses advises caution on drawing strong inferences from these estimates. Food producers/tech SMEs also scored highly across the enabler categories (mean 23.5%), mainly reflecting cost (64.1%) and geographic proximity (46.2%).
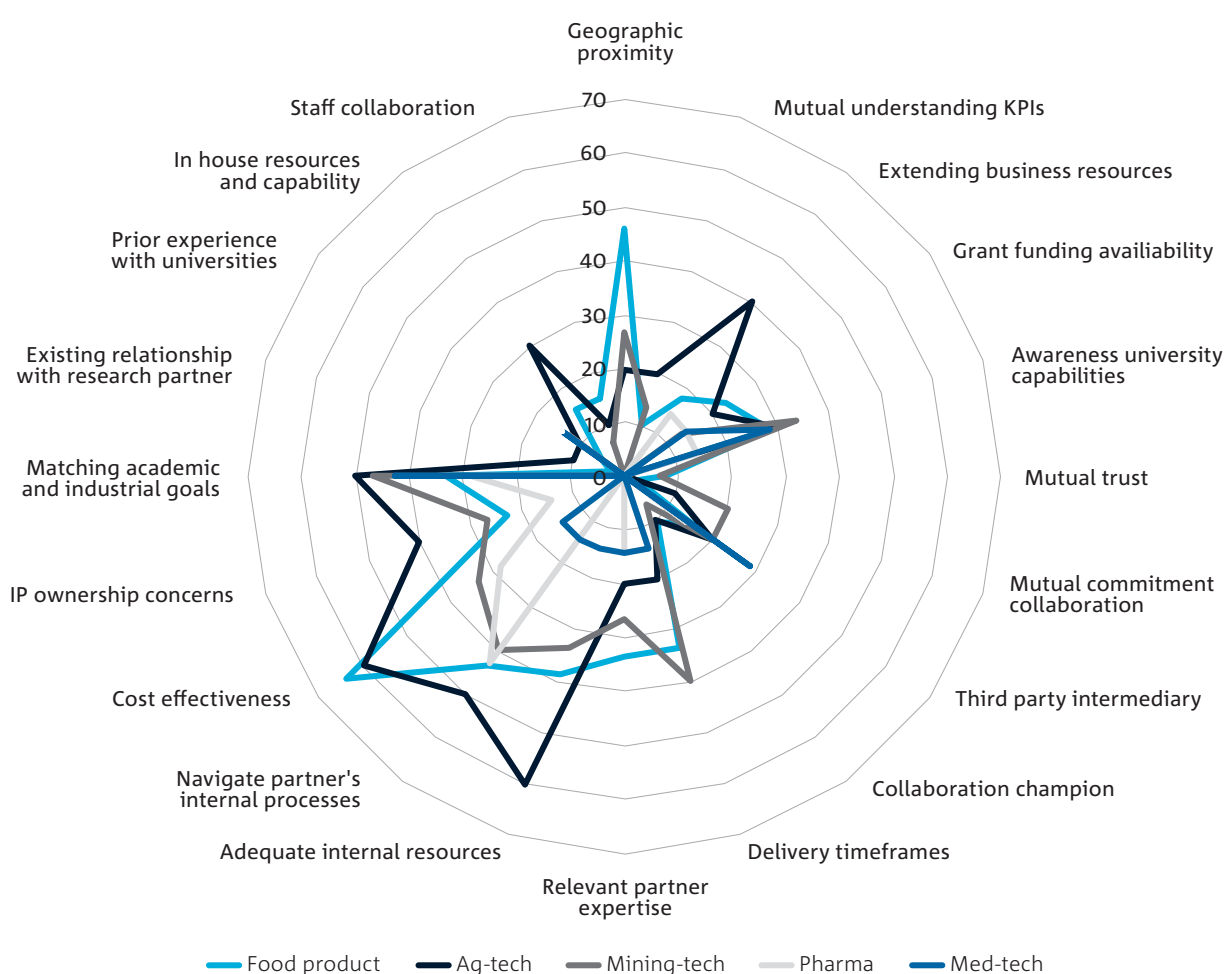
Figure 21: Collaboration enablers and tech industries

5.8 Knowledge sources – with whom do SMEs partner

For the whole sample of collaborators and non-collaborators, the two most important knowledge sources were clients or customers (mean response of 4.3) and suppliers (4.0) (Figure 22). Relative to non-collaborators, collaborators reported that their innovative activity was primarily sourced from beyond their supply chains, notably consultants, universities, public research institutes and commercial laboratories/research institutes.

When the respondents were categorised by firm size, there did not appear to be a significant relationship between knowledge source for innovation and firm size. Of the nine knowledge sources for innovation that were investigated, respondents across all firm ages consistently identified suppliers (mean response of 4.3 out of 5.0) and clients or customers (4.0) as the most important. Consistent with the patterns identified across firm age and size, suppliers and clients/customers were most often cited as knowledge sources across all industry sectors, but in particular for IT, healthcare, trade and other services.

1–5 LIKERT SCALE

■ Collaborators ■ Non-collaborators
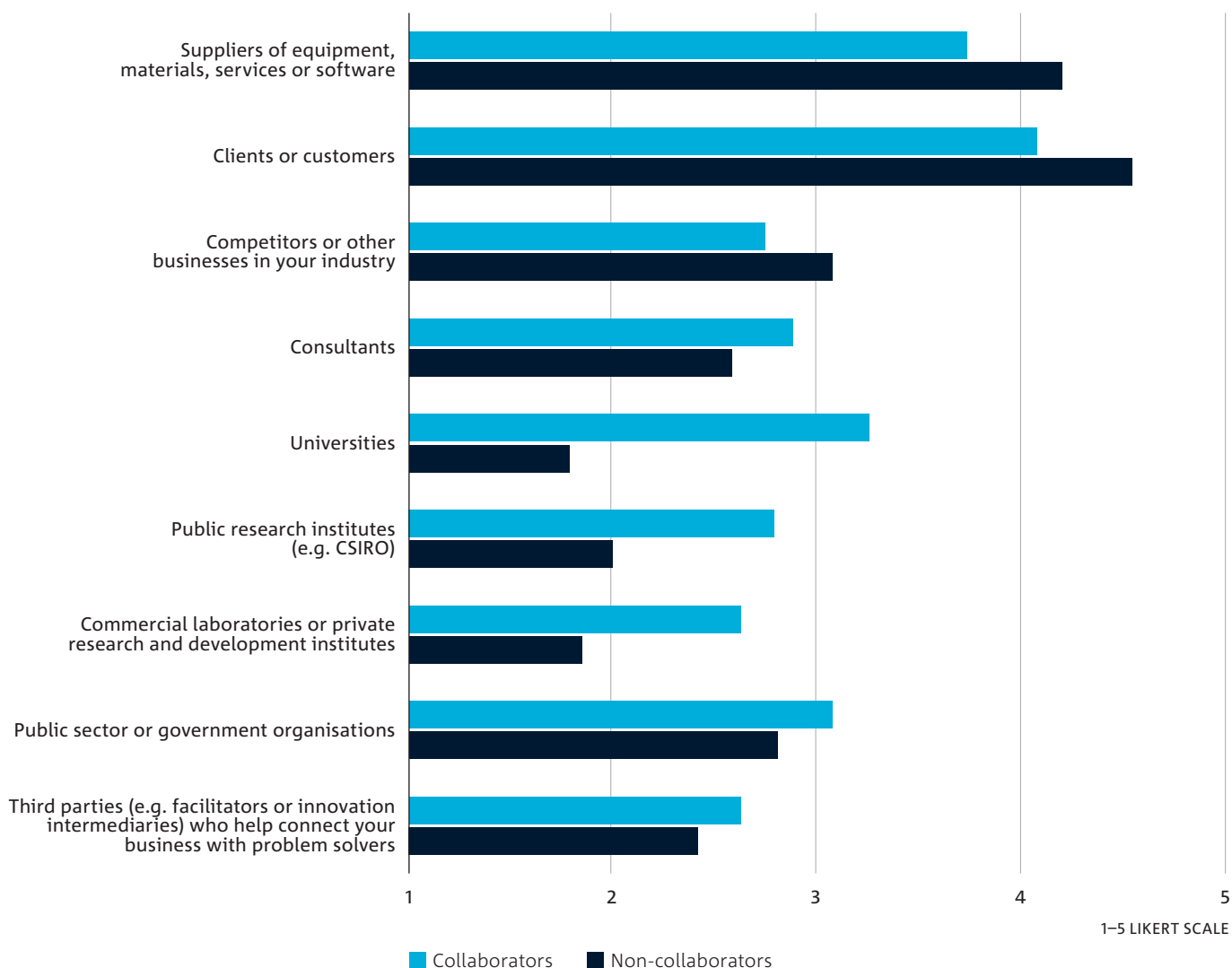
Figure 22: Knowledge source by collaborator type

5.9 Collaboration motivation

The survey asked collaborating firms what motivated them to engage with URIs (Figure 23). It was found that 88.0% were motivated by the ability to access specialised knowledge or consultancy. Other commonly reported motivations included creation of new products and/or processes (83.3%), and improved innovative ability and capacity (79.3%). The least commonly cited sources of motivation were outsourcing aspects of the business (26.5%), cost savings (40.3%) and risk reduction or sharing (41.3%).

5.10 Expected outcomes

Across all size cohorts of non-collaborating firms, four expected benefits were most commonly cited: improved competitiveness (88.3% of respondents), assisted management and/or staff development (86.3%), improved innovative ability and capacity (86.0%) and improved financial performance (86.0%).

There was little evidence of a pattern between firm size and expected collaboration benefits. Across industry sectors, businesses in mining were the most optimistic in terms of benefits from collaboration, with all mining firms expecting gains across nine categories, including improved market credibility and improved competitiveness. Similarly, all healthcare businesses expected collaboration with URIs to deliver benefits in terms of assisted management and/or staff development, improved financial performance and the hiring of talented graduates.

Figure 23: Collaboration motivation (collaborators)

5.11 Innovation

Those who indicated they engaged in innovation over the last three years, were asked which five types of innovation they had explored: services, products, processes, business model or organisational innovation (Figure 24). It was found:

- collaborators undertook a significantly greater level of product, process and business model innovation

- two-thirds of collaborators (66%, SD 47.4%) reported that they had designed or manufactured a new product, compared with 28.1 per cent (SD 45.0%) of non-collaborators

- 45.3 per cent (SD 49.8%) of collaborators had engaged in process-driven innovative activity than non-collaborators (29.7%, SD 45.8%)

- there was a significant difference in the provision of new or improved services, with 60.6 per cent (SD 48.9%) of collaborators having developed service innovations compared to only 53.3 per cent (SD 50.0%) of non-collaborators

- significantly more collaborating firms engaged in business model innovations that targeted customer value (47.1%, SD 50.0%) compared to non-collaborators (38.3%, SD 48.6%)

- 91.1 per cent (SD of 28.6%) of collaborators manufactured or designed products that were new to their industry, compared to 76.8 per cent (SD 42.4%) of non-collaborators

- most innovations were developed within the business, for 69.3 per cent of collaborators (SD 46.1%) and 59.2 per cent (SD 49.2%) of non-collaborators

- collaborators reported that URIs were important to developing innovation, while non-collaborators were more likely to have developed innovations with other businesses

- in total, 93.8 per cent of collaborators engaged in any of the five modes of innovation, slightly higher than non-collaborators (85%)

- there is little evidence of a relationship between innovative activity and firm age. However the youngest cohort (0-5 years) of non-collaborators exhibited substantially lower innovation activities (75.9%), than collaborators of the same age (97.4%).
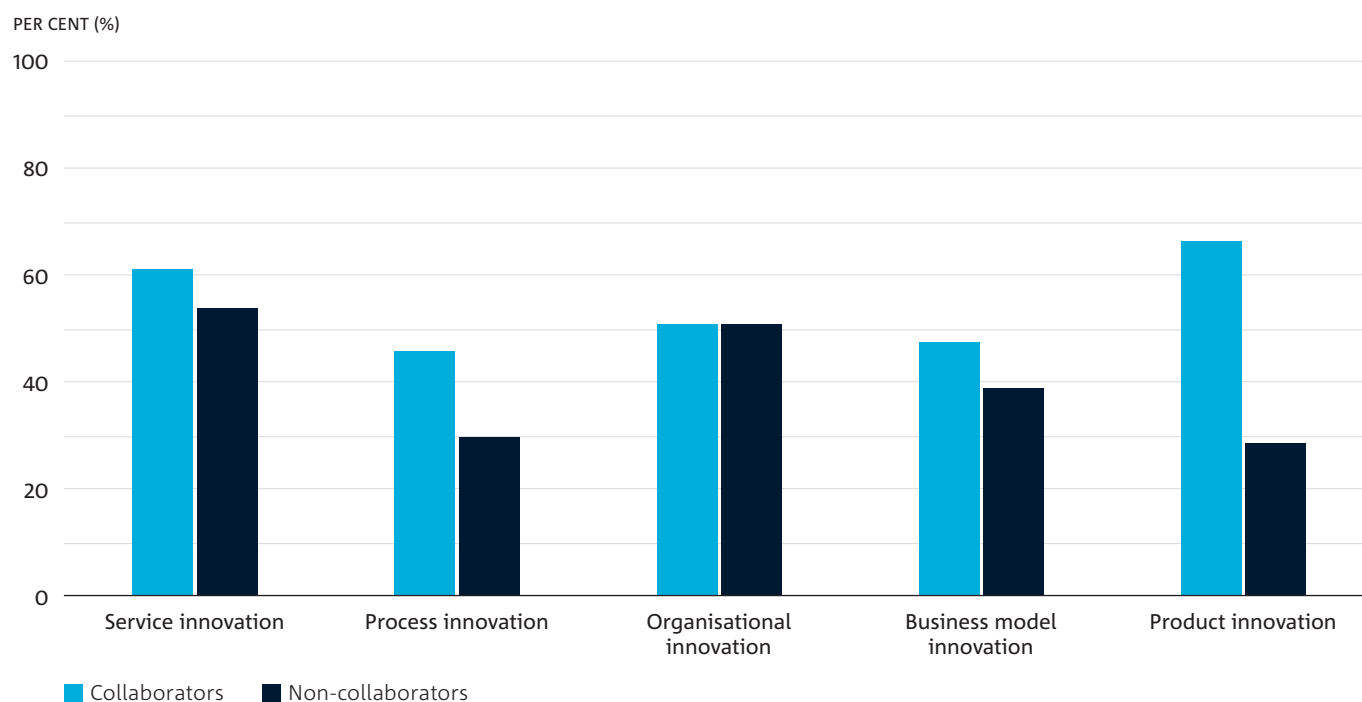
PER CENT (%)

Figure 24: Firms undertaking innovative activities

Business were then asked what percentage of sales derived from recent innovations, finding that:

- recent innovations represented 26.5 per cent of collaborating firms' sales (SD 29.7%), compared to 18.5 per cent (23.6%) for non-collaborating firms

- there is an inverse and monotonic relationship between firm size and the share of innovation sales; smaller firms earned a larger percentage of sales from innovations than more mature firms (Figure 25)

- there is an inverse relationship between firm age and the share of innovation sales; collaborating firms that are less than 10 years old reported that innovations accounted for no less than 40 per cent of total sales, compared to no more than 25 per cent for firms that were 11 years or older. This pattern is very interesting and denotes that older firms tend to have their sales less linked to innovation whether they collaborate with URIs or not

- among collaborators, the industries with the highest percentage of innovation sales were professional services and education (33.5%) and construction (30.3%), while the industries with the lowest innovation sales were agriculture (20.9%) and mining (21.8%).
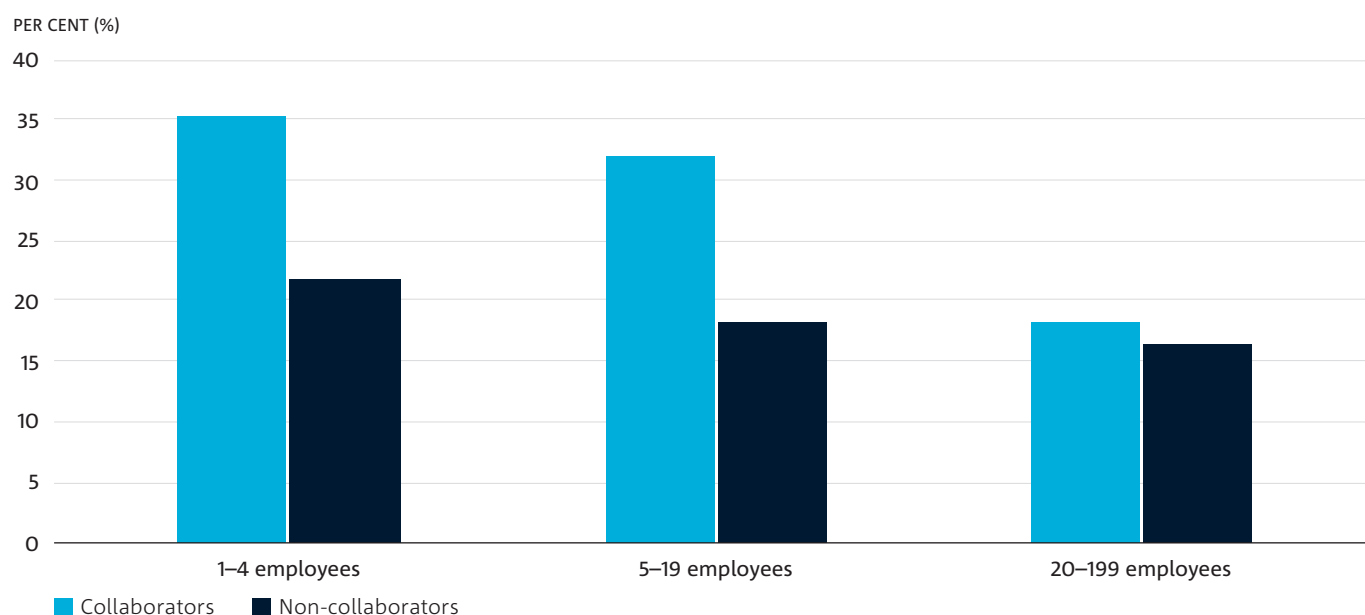
PER CENT (%)

Figure 25: Percentage of innovation sales and firm size

Comparing innovation activity in collaborating verses non-collaborating firms in general:

- collaborators exhibited a greater propensity for new-to-industry innovations. 85.9 per cent (SD 34.8%) of collaborating firms brought new-to-industry innovations in the form of new or significantly improved service provision compared with 67.5 per cent of non-collaborators (46.9%)

- for non-collaborators, there was a positive and monotonic relationship between size and product innovations and service innovations

- there was a negative relationship between the percentage of sales derived from recent innovations and firm size for both collaborating and non-collaborating firms.

The majority of respondents from the entire sample reported that they mainly undertook innovation within their business (Figure 26), with the mean response rate of 64.6 per cent, and with a higher mean response from collaborators (69.4%) than non-collaborators (59.2%). The second most commonly reported innovation development was in collaboration with other businesses, with a mean response for all businesses of 16.6 per cent. Fewer than 15 per cent of all businesses surveyed reported that their innovative activities were mainly undertaken in collaboration with URIs.

The key finding that the majority of innovative activity by all the responding businesses took place mainly within their business was evident across all of the industry sectors, with 76.5 per cent of businesses in manufacturing and utilities and 74.3 per cent of agricultural firms reporting such. By contrast, 50 per cent of IT businesses indicated that most innovation was done within their business.

PER CENT (%)
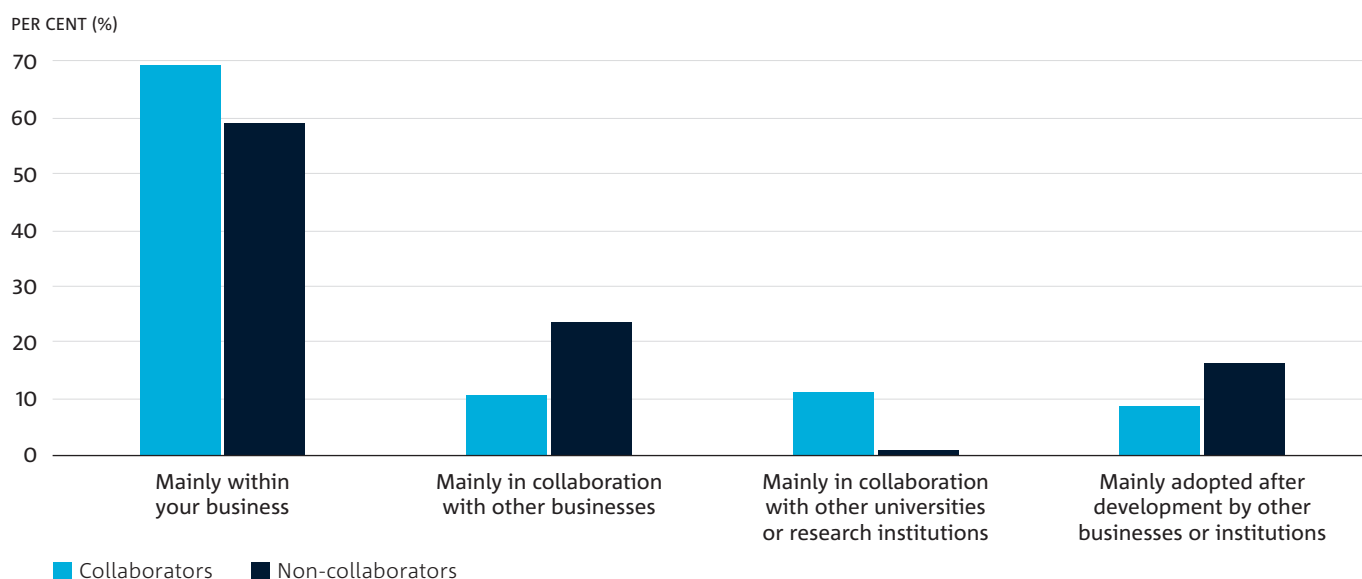
Figure 26: Innovation developments and firm age across all businesses

5.12 COVID-19

Participants were asked to rate the impact the COVID-19 pandemic had on four aspects of their business' strategy (Figure 27). Overall, SMEs experienced a greater impact on short-term strategies, including those that have necessitated changes to business models. The mean response to the impact on short-term strategies was 3.9 (SD 2.0) while the mean response to COVID-19 necessitating changes to business models was 3.6 (SD 2.1). The impact was slightly lower for long-term strategy with a mean response of 3.4 (SD 2.0) for collaborators and 3.3 (SD 2.1) for non-collaborators.

The analysis suggested that the impact of the pandemic was greater for non-collaborators, which could be attributed to their smaller average size that left them more exposed to lockdowns and business disruption. Among non-collaborators, the impact of COVID-19 appeared to be modestly greater for their short-term (3.8, SD 1.4) compared to their long-term strategy (3.3, SD 1.4) and expected innovation activities in 2021 (3.2, SD 1.5) (Figure 28). No distinct pattern emerged between the impact of the pandemic on the plans and business models, and firm age. Furthemore, no discernible pattern could be identified between firm size and the impact of COVID-19 on business models or strategy for collaborating businesses.

5.13 Indicators of collaboration

Factor analysis, correlations and regression analyses were used to investigate the direct effects of enablers and barriers on SME-URI collaboration. It was found that collaborating with URIs was highly correlated with innovations ($p>.00$). This is particularly important because it is known how critical innovation is to SMEs' exports (Golovko & Valentini, 2011), growth and net financial income (Saunila, Pekkola, & Ukko, 2014), as well as to the overall economy through job creation, economic output and spillovers (Wong, Ho, & Autio, 2005). This confirms our earlier assertion that SME-URI collaboration is critical for innovation.

Factor analysis showed that enablers and barriers could be grouped into three different factors (Figure 28). The first factor, called 'operations', referred to geographical proximity, availability of funds, costs, IP and navigating URIs' bureaucracy. The second factor related to trust, mutual understanding, existing or previous knowledge and experience with URIs, and mutual commitment; called 'relational'. The third factor, called 'resources and capabilities', referred to the importance of SMEs having the necessary resources and capabilities to engage in collaborations, the willingness of SME staff to engage in collaborations, and a clear understanding of URIs' resources and capabilities. These factors are important because they show how SMEs organise their thinking around URI collaboration. For them, it was important to get the operations right, understand their and the URI's resources and capabilities, and, finally, mitigate these risks through relational factors.

LIKERT SCALE 1–5
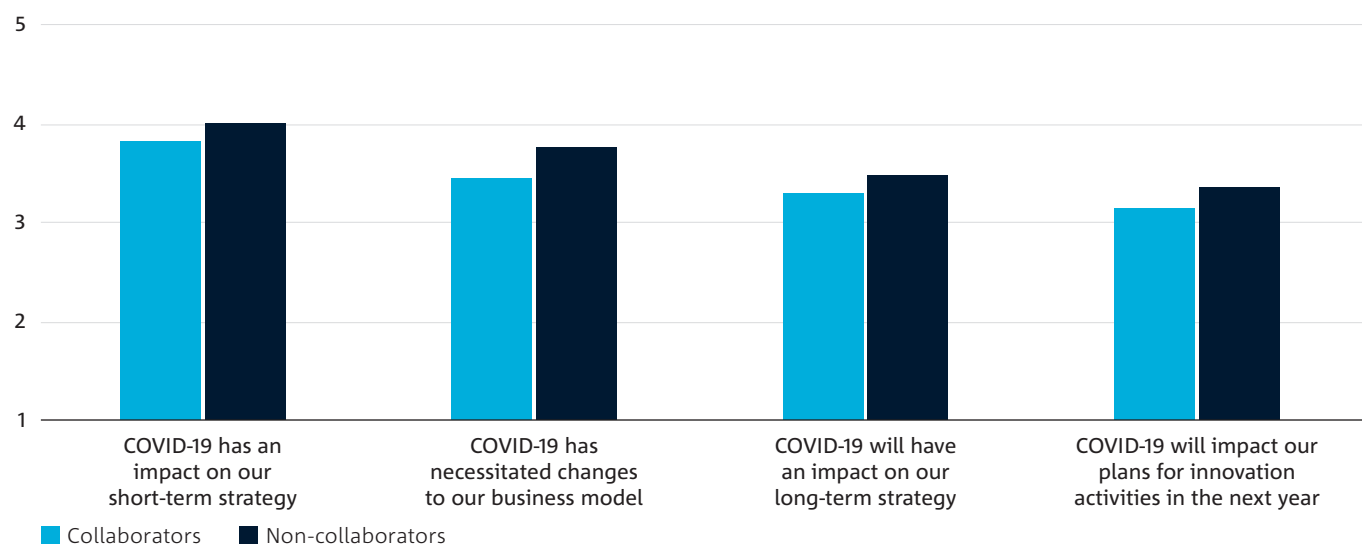
Figure 27: Comparing collaborators and non-collaborators against COVID-19 impact

These barriers and enabler factors were used to predict collaborations using regression analyses. Results show that larger firms engage more in collaborations ($p=.01$) but also that operations and resources and capabilities enablers impacted collaborations ($p=.01$ and $p=.05$ respectively). Similarly, the relational barrier factor impacted collaborations ($p=.01$). These results further emphasise the importance of the relational dimensions that SMEs attribute to SME-URI collaborations and how they see these as detrimental if not properly addressed. While there is little reason to mistrust institutional frameworks in Australia, with for example high standards, the rule of law and enforceability, it seems that SMEs have difficulty trusting URIs' capabilities, resources and ability to deliver. Validating and understanding this problem is an important avenue for future investigation.

5.14 Summary

In summary, the analysis of survey data highlighted:

- Collaboration occurred across a broad range of research- and training-focused activities, with micro and high-tech firms more likely to engage in those that were research-focused.

- Collaborating firms were motivated by factors directly related to performance outcomes when collaborating (e.g. gaining patents, access to equipment and capability, outsourcing). However, unexpected outcomes often eventuated (e.g. new products/processes), while some expected outcomes (e.g. patents and outsourcing), did not.

- Enablers of collaboration tended to be resource-oriented, for example focused on funding, cost-effectiveness and extending resources.

- Collaborators found some enablers significantly more important than non-collaborators, including match of rigour and relevance, ability to navigate URIs' structures, delivery time frames and internal resources.

- Barriers tended to be relationship focused, for example trust and mutual commitment.

- Previous experience, an existing relationship, mutual commitment to the collaboration and the presence of a collaboration champion were significantly more important barriers to collaborators than non-collaborators.

- Micro firms engaged in light-touch activities. Medium sized firms ranked the highest on collaboration activities.

- Firms in high-tech industries were more likely to collaborate in general.

- A small proportion of SMEs undertook their innovative activities mainly with URIs and those firms were more likely to introduce new-to-industry innovations.

- Collaborating firms where better positioned to deal with COVID-19 related disruptions.

Recommendations, presented next, have been guided by these survey findings, coupled with data from the interviews/focus groups and literature/media analysis.
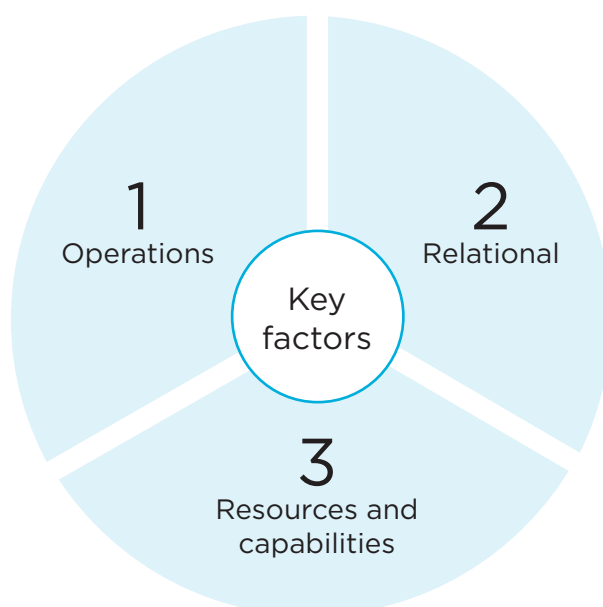
Figure 28: Key factors in collaboration

6 Implications and recommendations

RMIT presents their logic (see example below) and recommendations that tie together the enablers and barriers, antecedents and mechanisms identified as important, for successful collaborations to generate impactful outcomes.

Antecedent	Enabler/barrier	Recommendation	Expectation

6.1   Access and availability of funding for collaborations

Resistance and different motivations of URIs and SMEs	Institutional funding	Increased and continuing institutional funding	Increased number of SME-URI collaborations

SMEs are known for being resource poor (Verreynne et al., 2016) and, therefore, have to be parsimonious in resource allocations to support activities with clear and desired outcomes. R&D and working with URIs are not usually core activities and therefore need to be seen as low-risk. This means funds, time and other resources needed to collaborate were juxtaposed with potential benefits. Funding was able to reduce SMEs' uncertainties around less than optimal use of resources and capabilities and the opportunity costs attached to this. As one owner said during the interviews: *"…it is too risky for us if no funding is available because there is too much uncertainty"*. Therefore, to mitigate these perceived risks, particularly for SMEs, the opportunity to access funding was seen as a very important enabler. With funding available, it is expected that an increase in SME-URI collaboration is likely, as suggested by the data, pointing to an increased likelihood of subsequent collaborations for firms with prior experience.

Recommendation 1: A continuing role for institutional funding in supporting (initiating and fostering) SME-URI collaborations

Micro and young SMEs' mindsets towards innovation and collaboration	Eligibility criteria of some institutional funding programs	Broaden the eligibility criteria	More collaborations, innovation, job, etc.

The literature review and interviews highlighted that funding schemes' eligibility criteria rarely focused on young and micro organisations. However, this initial phase is critical for new SME establishment as this is a time during which businesses need to test, validate, augment their limited resources and capabilities, and look for new solutions. Therefore, it is suggested a broadening of the eligibility criteria for some of the available institutional funding programs to consider young and micro firms. Following on from the previous recommendation, experience in SME-URI collaboration positively affected future collaborations. Hence, it is beneficial to start building relationships as early as possible.

Recommendation 2: Opportunity for eligibility criteria of institutional funding to be broadened to allow young and micro firms to engage more readily in collaborative arrangements with URIs.

| Complex problems that require multiple partners | Positive effects of multiple partners | Funding accessibility to include multiple partners | Complex problem solved and distributed by different stakeholders |

Previous exposure to inter-firm partnerships were identified as enablers of consequent SME-URI collaborations. Such experience can be with different partners, and, in interviews, several SMEs asked for programs where they could mitigate project risks by bringing other industry partners or URIs into the collaboration. Having multiple partners in collaborative arrangements has the potential to tackle complex problems, help to mitigate risks, capture more resources and capabilities, and reduce time.

Recommendation 3: Eligibility criteria of institutional funding should be broadened to allow multiple stakeholders to be included in the same project.

| Funding schemes with different submission systems | Complexity to facilitators and URIs | One entity to manage funding schemes or similar system/criteria | Economies of scale – time, e.g. efficiency, cost |

Senior- and executive-level managers from URIs noted time-related barriers to collaboration created by bureaucracy, such as the different submission systems of institutional funding support. Negotiating these different and complex systems required extra resources and costs, and led to slower response times.

It is recommended that institutional funding should be managed through a single entity, with a unique submission system and template across schemes or grants. This will generate economies of scale for funding bodies, and create costs savings and support efficiencies at URIs, thus increasing researchers' motivations to engage in collaborative arrangements with businesses.

Recommendation 4: Create a mechanism to better coordinate different research and collaboration funding schemes, potentially through a single organisation or system.

| Institutional funding continuum | No connection between the stages of institutional funding | Introduction of a criterion of successful past collaboration | SMEs and researchers create long-term pipeline |

Interviews with researchers confirmed their lack of interest to collaborate with SMEs was partly due to the short-term, small projects that such collaborations frequently entailed. Through desktop and empirical research, evidence was found that SME-URI collaboration could benefit from being financially supported using an incremental approach, according to the maturity of the collaboration. Furthermore, it was clear that SMEs with past collaborative experience with URIs were more likely to engage in subsequent collaborations.

Previous experience decreases SMEs' perceptions of risk. Therefore, it is recommended specific funding schemes are designated to initiate collaboration that leads directly into other schemes aimed at scaling-up or sustaining existing collaborations. This holistic and longitudinal view of funding could incentivise SMEs and researchers to see collaborations as long-term and therefore justify the costs associated with initiating a new collaboration.

Recommendation 5: Create a holistic view of the pipeline of different funding schemes, with some designated to initiate collaborations and others focused on scaling-up or sustaining existing collaborations.

| Lack of understanding between SMEs and researchers | Mistrust between SMEs and researchers | Increase engagement channels | Increase the number of SME-URI collaborations |

The survey showed that 'existing relationships with URIs', 'mutual trust' and 'mutual commitment' were some of the most significant barriers to collaborations. Absence of trust diminished the chances of successful collaboration. From the interviews, it is understood this lack of trust was related to the lack of understanding and knowledge of the counterpart. It is therefore suggested that new programs include 'boundary-spanning' activities, such as staff exchanges and student internships.

Recommendation 6: Create incentives towards multi channel engagement between SMEs and URIs, through staff exchanges, student internships, and casual placements, among others.

In summary, it was found that institutional funding is critical for SME-URI collaboration. Eligibility criteria should be broadened to include young and micro firms and also engage multiple partners. It is also suggested a single entity manage the research and collaborative arrangements between corporations and URIs. This entity would have a holistic view of all available schemes, curating a pipeline of funding for progressing successful collaborations; be a unique contact point between URIs, SMEs, and government funders; and have the ability to utilise synergies between similar application systems. Subsequently, this will allow URIs and funding bodies to reduce complexity around institutional bureaucracy, with immediate benefits being economies of scale, efficiency and cost reduction. This centralised and holistic system will also allow researchers, SMEs and facilitators to see potential future avenues when engaging in initial research collaborations.

6.2 Individual and relational factors

| SMEs with different R&D exposure levels | No differentiation on institutional funding programs | Refine eligibility criteria | Foster collaboration and innovation outomes |

The survey results showed that SME owners/managers with higher formal education qualifications were more likely to collaborate. Interviews with facilitators confirmed this was due to familiarity with URIs. The data also shows that previous URI exposure leads to repeat collaborations, therefore it is recommended that additional support be given to SME leaders unfamiliar with URIs. Refining eligibility criteria in this way will allow for a better allocation of institutional resources towards projects that are likely to succeed and extend into future collaborations.

Recommendation 7: Tailor SME-URI collaborative arrangements or support to the research and training exposure of SME owners/managers.

Mistrust between SMEs and URIs	High risk of engaging in collaboration	Relationship building mechanisms	Reduce the risks to a tolerable standpoint

Trust is of paramount importance for successful collaborations and can only be built through time and experience. The survey results, supported by the interviews and literature review, point to a lack of trust as a barrier for SMEs to engage in URI collaborations. Accordingly, the development of relationship building activities is encouraged, for example, matchmaking and networking events designed around complementarity capabilities; development of incentives and programs that support participation in small-scale initiatives (e.g. participation in an advisory board); or professional mobility through secondments. Furthermore, training should be implemented, in conjunction with facilitators, to increase both SMEs' and URIs' awareness of what is happening in each of the current silos (URIs and SMEs); this training can be industry-specific to allow for the different needs and types of SMEs.

Recommendation 8: Develop relationship-building and training activities between SMEs and URIs, building on the expertise of facilitators and URIs.

SMEs with different mindsets towards innovation and collaboration	No differentiation on institutional funding programs	Maturity model to differentiate institutional support	Support collaboration that produces higher innovation/value

The results from the survey show that URI-collaborating SMEs tend to be more innovative than their counterparts; collaborators undertook a significantly greater level of innovation activities and were more likely to design new products, engage in business model innovation and introduce new-to-market products and services in comparison with non-collaborators. It was also found URI researchers differed in terms of collaborative experience and mindsets. Therefore it is recommended that a collaboration readiness index for SMEs and URIs is created, leading to deployment of a maturity model to evaluate SMEs and researchers and reduce the likelihood of unsuccessful collaboration.

Recommendation 9: Develop a maturity model, coupled with a collaboration readiness index, to focus support on potential high-value collaborations.

In summary, organisational, individual and relational factors are critical to initiate, develop and sustain collaborative arrangements. Identifying individual and organisational characteristics is important in focusing institutional support more efficiently, as this seems to improve collaboration outcomes. Relational factors also have an important role in initiating, developing and sustaining collaborations and individuals should be incentivised to support long-term relationships.

6.3 Facilitators

Different expectations of SMEs and researchers	Facilitators	Institutional funding for facilitators	More and higher success rate of collaborations

The engagement of a facilitator was identified as a highly important enabler for collaborating firms. Facilitators help SMEs and researchers understand their objectives, perceptions of time and risk, and motivations. An experienced facilitator understands the expectations of SMEs and researchers and leads them towards outcomes that satisfy the objectives of both parties. This is particularly crucial, as it is known that failing to align expectations is a key barrier to successful SME-URI collaboration.

Another reported barrier for SMEs was the complexity of navigating URIs' internal structures. Again, an experienced facilitator can help simplify this aspect. It is expected that facilitators enhance the quality and quantity of collaborations and recommend the use of facilitators as intermediaries between SMEs and URIs in most circumstances (Figure 29).

Recommendation 10: Facilitators, as collaboration intermediaries, are critical to the establishment and ongoing success of SME-URI collaborations and therefore should be part of any institutional funding schemes targeting such collaborations.

Help SMEs identify their research needs —
Provide information —
Connect SME and URI staff —
Guide through administrative processes —

— Support communication
— Support relationships
— Clarify IP concerns
— Assist with project management

Facilitators

SMEs

Collaboration

URIs

Institutional funding

Figure 29: Dynamic quadruple helix model

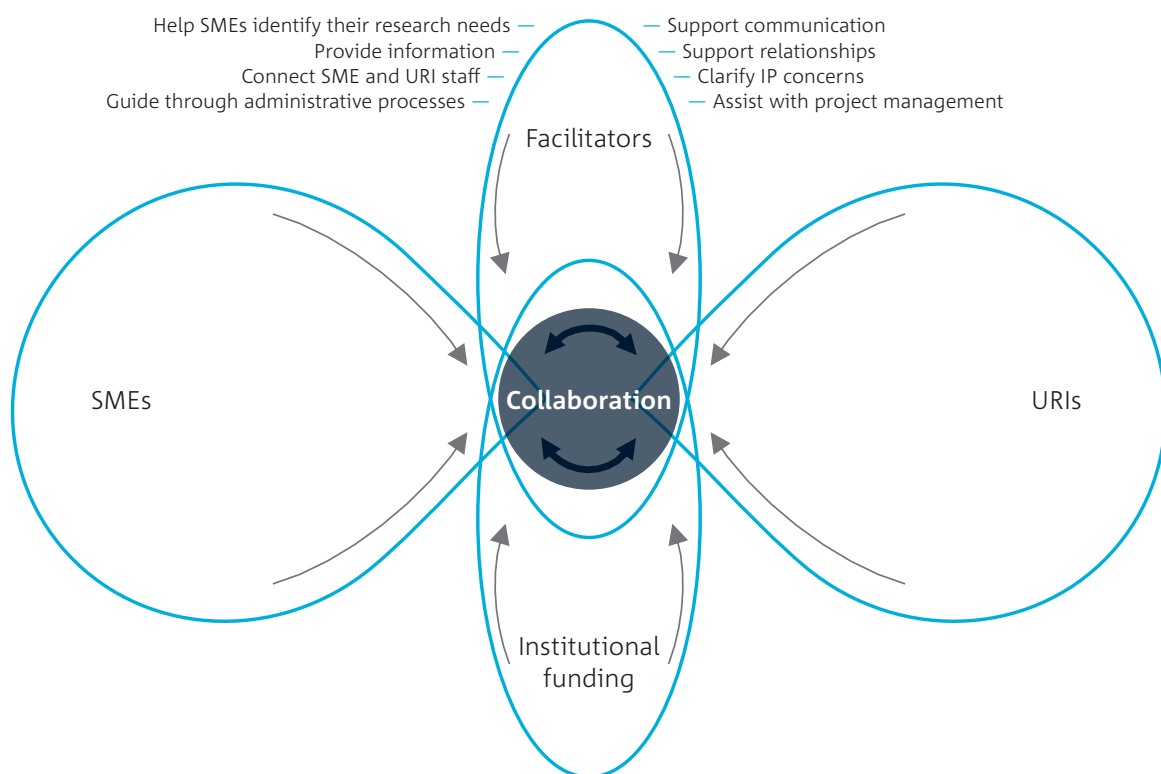| Regional mindset | Lack of best possible matching | Create incentives to break the regionalism mindset | Higher value for the collaboration |

Another important theme that emerged from the interviews related to facilitators' matchmaking abilities and centralised mapping of the resources and capabilities of URIs across Australia would be beneficial. This should be frequently updated and matching should be encouraged on a best-fit basis without regional bias.

Recommendation 11: Facilitators should have a database of URIs' resources and capabilities available and should be incentivised to encourage inter-regional collaborations when appropriate. A digital repository should be developed to support the codification of capabilities, and an open platform to facilitate the matchmaking and brokering activities should be designed.

| Negative collaboration experiences | Lack of trust between SMEs and URIs | Project management systems | Alligment of expectations and orientation to the results |

Lack of trust between SMEs and URIs leads to weak mutual commitment towards collaboration, communication and misaligned expectations. It is recommended that URIs use a project management system, supported by the facilitator or core unit, that monitors objectives, outcomes and processes against expectations. The project management system will, for example, have specific milestones with dates and responsibilities, the ability to be checked and signed off by the different parties when deliverables are met, and deal with other project-related issues such as budgets.

Recommendation 12: Facilitators should provide a systematic approach, coupled with project tools, for SMEs and researchers to access and manage budgets, milestones, and other aspects of the collaboration.

In summary, facilitators are a critical dimension of a quadruple helix framework, and data showed how important they are to fostering and managing collaborative arrangements between SMEs and URIs. A group of recommendations has been proposed that can improve the facilitation role by better matching SMEs' needs with URIs' capabilities and resources, and by aligning expectations between SMEs and researchers.

6.4 URIs

| Publicly funded institutions with public value concerns | URIs' IP concerns | A more flexible approach to IP; and create template agreements | Speedier and easier contractual process |

An important topic that emerged from the survey and interviews related to IP provision, which was particularly important to non-collaborators. This was echoed by senior and executive managers of URIs, researchers, SME owners, and facilitators, who all criticised the hard-line that many URIs have around IP. This was acknowledged by URI managers, who referred to it as a 'legacy' and 'cultural problem', and that IP often remains unused following collaborations. Therefore it is recommended that there is a change in approach to URI-developed IP. This concerted effort should follow the logic of 'sharing' for maximum impact instead of 'owning, and should guide a collaborative spirit underpinning institutionally funded collaborations between SMEs and URIs. The creation of IP and contract templates that are agreed upon should be institutionalised and system-wide change could be achieved through for example, new directives/funding conditions related to IP rights/ownership.

Recommendation 13: URIs should adopt a more flexible approach to IP rights/ownership, supported by broader institutional initiatives.

| URIs' different divisions dealing with SME collaboration | Time and complexity of setting up collaborations | URI best practice for dealing with SME collaboration | Speedier and easier contractual process |

An important barrier identified by the researchers, facilitators and SMEs referred to URI operations. Researchers and facilitators were very vocal about the different objectives, KPIs, and motivations that different URI departments have. The small size, complexity and often short duration of these collaborative research efforts remained unacknowledged, and URIs' administrative systems and procedures treated them as if they were large, complex, and long. To improve this, it is recommended that administrative operations are streamlined and there is undertaking to better communicate expectations and outcomes of SME-URI collaborations. Furthermore, highly engaged researchers could provide training or mentoring within their URIs to other researchers and staff.

Recommendation 14a: Streamline operations in the collaboration set-up phase.

Recommendation 14b: Develop a network of SME-URI champions within URIs who can advise, assist and mentor academics and professional staff.

Recommendation 14c: Support the behavioural changes by strategically communicating successful SME-URI engagement cases within URIs.

Recommendation 14d: Create a series of case studies of URIs that highly and successfully engage with SMEs that can be used by facilitators during the engagement phase.

| Overhead costs of URIs on SME collaborations | Available money for the R&D project | URI training/information sessions | Improve researchers' perceptions of value |

During the interviews, researchers and facilitators raised the issue of imposing URI overhead costs on small and short-term projects. This is particularly relevant for SME-URI collaborations as usually the money available for the research is small and there is little room for financial negotiation. As such, it is recommended that URIs view these smaller SME-URI engagements as seed projects to future collaborations and should reduce overhead costs as part of future pipeline investment.

Recommendation 15: URIs should consider SME-URI collaborations as seeding further and larger projects and therefore consider them as investments and reduce or waive overhead costs.

| Researchers' KPIs | No real incentive for researchers to engage with SMEs | Train the facilitators/ direct incentive to the researcher | Higher rate of researchers interested in SME collaboration |

Collaborating SMEs viewed a lack of understanding of mutual KPIs as a major barrier to collaboration. It is therefore recommended that facilitator training should include understanding of incentives, motivations, KPIs and long-term objectives of both SMEs and researchers. It is also recommended that URIs have KPIs, and funding bodies have eligibility requirements, that acknowledge applied research and industry funding.

Recommendation 16a: Provide training/information to facilitators on incentive structures for different parties involved in SME-URI collaborations.

Recommendation 16b: Encourage URIs to strategically recognise SME collaborations by providing a framework for integrating such forms of collaboration into incentive and appraisal systems.

Recommendation 16c: Encourage research funding bodies to take into consideration industry engagement activities, particularly with SMEs, in the evaluation of the track record of grant applicants.

In summary, many URIs' internal processes, costs, ideologies around IP, and incentives towards SME-URI collaborations need to be rethought. URIs' bureaucracy, costs and IP and contracting regimes seem to be central barriers to such collaborations. Inaction on this front will continue to jeopardise the number and success of SME-URI collaborations.

6.5 SMEs

| Knowledge of URIs' capabilities, resources and mindset | Working with URIs is difficult, takes time, and is not useful | Networking, fairs, conferences, visits, and workshops | Awareness of URIs' capabilities, resources and mindset |

The survey results and interviews indicated a disconnect between SMEs and URIs around mindsets, processes in establishing collaborations, and knowledge of capabilities and resources available. To mitigate this, it is suggested SMEs individually, or through industry associations, be more engaged in networking activities with URIs. For example, SMEs could be incentivised to take part in industry fairs, specialised conferences, or partake in organised visits and workshops organised by URIs. These networking activities will improve the awareness of URIs' resources and capabilities and potentiate future collaborations. While also increasing understanding of the mindset of SMEs to researchers and visa-versa.

Recommendation 17: Organise and participate in networking opportunities, such as fairs, conferences, workshops and visits, to improve SMEs' awareness of URI resources and capabilities. Ensure these opportunities are practical and relevant to business.

| Lack of awareness of the importance of innovations | No focus on new products/service | Training | More collaborations, innovation, jobs |

While the survey pointed to common SME investment in new processes and practices, an important observation was the lack of ground-breaking innovations created by SMEs; innovation activities were mostly reactive and incremental. The data also showed that collaborating SMEs were more likely to innovate, and that having a innovation mindset encouraged researchers to work with SMEs, since researchers are typically interested in solving new and unique problems. It is therefore recommended that training for SME decision-makers on the value and importance of innovation.

Recommendation 18: Provide training opportunities to SMEs related to the benefits of innovation and collaboration.

| Collaborating with URIs is risky | Mistrust between investment and outcomes | Incentives, URI student/ staff allocation to SMEs | Reduce the risks to a tolerable standpoint |

Even SMEs attuned to the benefits of collaborating with URIs can view new collaborations as risky. Any SME decision regarding R&D resources and capabilities needs is carefully considered, and a likely return on investment calculated, before committing to new collaborations with URIs. To reduce this risk, it is recommended there are incentives for SMEs to collaborate with URIs and these should extend beyond specific R&D funding.

Recommendation 19: Carefully review incentives to consider the pipeline activities needed to foster SME-URI collaboration and subsequent innovation.

| Mistrust between SMEs and URIs | High risk of engaging in collaboration | Submit some of the SMEs' problems to URI students/classes | Diminish the mistrust between SMEs and URIs |

Previous recommendations highlighted the high levels of mistrust between SMEs and URIs and how this impacted potential collaborations. As such, it is recommended SMEs should submit their less complex problems to URIs and have students solve them to help build relationships between parties. This should be done at no cost to the SME. This approach is also beneficial to students and their skills development, as projects will involve real-world problems and outcomes.

Recommendation 20: SMEs should be incentivised to submit their less complex problems to URI units or departments.

| High-tech industries are unique | Different requirements | Tailored programs to high-tech SME-URI collaborations | Improve the outcomes from high-tech SME-URI collaborations |

Survey results showed that food-tech, ag-tech, mining-tech, and pharma and med-tech industries have specific innovation requirements. Therefore, different high-tech industries will require defined approaches to collaboration based on their industry specificities. Tailoring of SME-URI collaboration programs towards specific high-tech industries has the potential to better support those industries and allow for successful arrangements that result in better outcomes. For that purpose, a group of recommendations is proposed:

Recommendation 21a: Tailored collaboration programs for SMEs in high-tech industries with URIs.

Recommendation 21b: Facilitators should be trained on the specific requirements that some industries have and create facilitator leaders for targeted high-tech industries.

Recommendation 21c: Due to the shorter innovation cycle in high-tech industries, these SMEs should, through industry associations, identify common problems to be solved with URIs.

In summary, SMEs should be more proactive in undertaking networking opportunities with URIs to raise awareness of their capabilities. While, URIs and government have a role to play in improving access for SMEs to engage with URIs and provide capability development opportunities, often following a stepwise approach. These opportunities should be tailored by industry to ensure that the specific needs of high-tech industries are addressed.

6.6 Media

| Focus on the research project | Lack of communication around positive case studies | Communicate the success cases and gains for each party | SMEs/researchers quickly understand the benefits of collaboration |

From the media analysis, it was apparent that little reporting about SME-URI collaborations occurs in Australia, and when it does,it lacks depth and does little to encourage SMEs to engage in similar collaborations. This reinforces the negative perception of SME-URI collaborations in society. Additionally, there is an apparent lack of strategy from stakeholders for communicating positive case studies where SMEs or URIs have benefited from such collaborations. With that in mind, it is recommended that facilitators, URIs and government should proactively manage media engagement to increase the awareness and benefits of collaborative activities.

Recommendation 22: Improve the communication around successful case studies by explicitly explaining what each party gains from the collaboration. This could be part of the facilitators' tasks when closing each collaboration project.

| Focus on the research project | Lack of communication around positive case studies | Yearly award for SME-URI collaborations | SMEs/researchers are motivated to continue |

Further legitimacy could be achieved by creating an independent body in charge of selecting and awarding the top SME-URI collaboration projects. This annual award would generate high visibility across relevant communities and would contribute to a behavioural change. The award committee could include a representative from SME peak bodies, Chambers of Commerce, university associations, governmental bodies, and facilitators.

Recommendation 23: Introduce annual awards for top SME-URI collaboration projects.

In summary, improved media coverage of successful case studies can mitigate negative perceptions of SME-URI collaborations.

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