Thematic Analysis of Institutional Reform, Intellectual Property and Commercialisation Academic Publications

Defence Trailblazer Research Program Extended Literature Review

DEFENCE TRAILBLAZER

A COLLABORATIVE PARTNERSHIP BETWEEN

THE UNIVERSITY of ADELAIDE | UNSW

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Executive Summary

The Defence Trailblazer: Institutional Reform, Intellectual Property (IP) and Commercialisation Review (the project), is a collaborative initiative between the University of Adelaide (UoA) and the University of New South Wales (UNSW). The program is funded by the Commonwealth Department of Education which aims to enhance Australia's sovereign capabilities through accelerated innovation in the Defence sector.

This report is the second output from Phase 1 of the project. It presents a thematic analysis of 105 peer reviewed academic publications.

The report examines the factors affecting university-industry collaboration (UIC) with a specific focus on:

1. Institutional reform and culture change; and
2. Intellectual property and commercialisation.

The report analyses and presents each theme at macro, organisational, team and individual levels and, in the case of IP and commercialisation, at an interorganisational level as well.

UICs involve multifaceted ecosystems with complex interplays among organisational, team, individual, and macro-level factors. Each level brings unique attributes and dynamics to the collaborative process, with the potential to either foster synergies or create friction. When effectively aligned, these factors contribute to a collaborative environment that supports innovation, knowledge transfer, and mutual benefit. Conversely, misalignment or conflicting priorities across these levels may obstruct the collaborative process, curtail operational efficiency, and diminish the overall impact of UICs. Hence any interventions that address issues at any of these levels need to consider the interplay between levels.

Table 1 contains a summary of the key themes and variables from the 105 journal articles in the current academic literature.

Table 1: Summary of main themes in the 105 academic journal articles

Level of Analysis	KEY THEMES: INSTITUTIONAL REFORM and CULTURE CHANGE	SUB THEMES: INSTITUTIONAL REFORM and CULTURE CHANGE	KEY THEMES: IP and COMMERCIALISATION	SUB THEMES: IP and COMMERCIALISATION
Macro	1. Government and policy influence	• IP policies • Funding mechanisms • Collaboration incentives	1. Policy frameworks	• Government funding and regulatory frameworks • IP enforcement mechanisms • Geographic/cognitive proximity factors • Digital collaboration and data governance • Market readiness and investment access • Innovation ecosystem support
	2. Ecosystem dynamics		2. Proximity related factors	
	3. Proximity	• Geographic, cognitive and institutional factors	3. Ecosystem dynamics	
	4. Digital transformation		4. Digital transformation	
Organisational	5. Institutional goals	• Academic vs. Commercial goals • IP secrecy issues • Need to become an entrepreneurial university	5. Institutional structures	• Academic vs commercial priorities • IP management and TTOs • Resource allocation and support systems • Institutional leadership and incentives • Knowledge absorption capabilities • Cross-sector communication protocols • Trust-building mechanisms
	6. Institutional values	• Knowledge sharing vs. market-driven outcomes • Timeline discrepancies	6. Resource and support systems	
	7. University processes	• Bureaucracy • Decision-making speed • IP management • Contract negotiation • Incentives	7. Organisational Culture	
	8. Resources and capabilities	• Availability of research facilities, expertise, funding support		
	9. Knowledge transfer and absorptive capacity	• Absorptive capacity of industry partners • Knowledge integration		
	10. Institutional attitude and social norms	• Attitudes toward industry engagement • Peer influence		
	11. Trust and understanding	• Mutual understanding • Communication barriers		
	12. Entrepreneurial universities	• Universities third mission • Entrepreneurial university ecosystems • Fostering an Entrepreneurial mindset and skills development, supporting policies and infrastructure, networking, scientific research • Technology transfer offices (TTO)		
Team	13. External engagement teams	• TTOs • Industry liaison roles	8. Composition and dynamics	• Academic-industry expertise mix • Project management capabilities • TTO intermediary roles • Research leadership development • Boundary spanning activities • Knowledge sharing practices • Collaboration dynamics
	14. Departments	• Roles of the Department Head • Department social norms and attitudes, leadership, peer support	9. Leadership	
	15. Composition and dynamics	• Having a combination of skills and experiences		
			10. External engagement and support	
Individual	16. Motivation	• Academic vs. industry motivations, attitudes, social norms, awareness, entrepreneurial mindset	11. Motivations	• Career advancement and research enhancement • Boundary spanning capabilities • Prior industry experience; cross-sector communication skills • Gender-based access factors • Commercialisation motivations • Network development
	17. Opportunities	• Seniority • Early career researchers • Networks • Time and work schedules	12. Boundary spanning	
	18. Capability	• Skills for cross-sector communication • Knowledge • Boundary spanning • Prior experience • Adaptability • Open communication • Self-efficacy	13. Gender and systemic barriers	
			14. Prior Experience	

1. Background

In 2022, the Australian Government committed $370.3 million to the Trailblazer Universities Program. Designed to build new research capabilities, drive commercialisation outcomes, provide new industry engagement opportunities, and to support Australia's strategic priority areas, the four-year program is an Australian Government investment toward Australia's Innovation Agenda.[1] The Department of Education awarded six Trailblazer programs, with each lead University receiving $50 million, to be matched by university and industry contributions.

In July 2023, the Defence Trailblazer Program (DTB) contract was awarded to the University of Adelaide and the University of New South Wales (UNSW). In July 2023, the Australian Government announced that the "Trailblazer project will create a defence industry of the future", stating that it would "develop 100 new products", creating over 1,000 new employment opportunities and an additional 1,400 jobs throughout the wider Defence industry.[2]

DTB is now an established consortium with over 95 partners. It aims to enhance Australia's sovereign capability through the acceleration of Australia's innovation agenda at speed and at scale.[3]

DTB activities centre on five strategically aligned areas including:

- Quantum Materials, Technologies & Computing
- Defensive Hypersonics and Countermeasures
- Information Warfare & Advanced Cyber Technologies
- Robotics, Autonomous Systems and AI; and
- Defence Space Technologies.

DTB also leads a range of cross portfolio activities in workforce innovation and culture aimed at supporting commercialisation activities.

DTB operates as part of the broader Defence Information Systems and Technology (IS&T) Ecosystem.[6] The Defence IS&T Enterprise includes Defence Science and Technology Group, the Advanced Strategic Capabilities Accelerator, and Group and Service IS&T elements.

Figure 1: Accelerating Australia's innovation agenda at speed and at scale through DTB [4]

There are also state-based university/industry/government defence collaborations within the Australian Defence Science and Universities Network (ADSUN), including the Defence Science Institute (Victoria and Tasmania), Defence Innovation Partnership (South Australia), Defence Innovation Network (New South Wales and the Australian Capital Territory), Defence Science Centre (Western Australia) and the Queensland Defence Science Alliance (Queensland and Northern Territory).[7]

Each of these has individual funding lines and seeks to develop technologies that will address Australian Defence Force challenges.

1.1. About the Research Program

The Defence Trailblazer: Institutional Reform, Intellectual Property and Commercialisation Review (the Research Program) aims to determine the effectiveness of the programs and initiatives undertaken within DTB. For activities that are determined to be effective, high-level commentary on their scalability to enterprise level and a recommended approach to implement across both University of Adelaide and UNSW is also sought."8 It is anticipated the Research Program will help determine the effectiveness of the approaches, programs and initiatives undertaken by DTB as it aims to achieve program objectives (i.e., IP Innovations and culture transformation). Findings from the Research Program will be delivered to the People and Culture Action Group (PCAG) for their consideration.

UNSW Canberra School of Business and University of Adelaide Business School will examine two primary areas of research:

1. Institutional reform and culture change (HR, policy, and processes) – UNSW: The research team will examine DTB initiatives to determine if they have created an environment where defence technology commercialisation can flourish, if this environment fosters collaboration between researchers and industry, and whether it incentivises successful and ongoing industry engagement.
2. Intellectual Property and Commercialisation – University of Adelaide: The research team will examine DTB initiatives to determine if they have created an environment that improves the management and access to IP, IP sovereignty, and defence technology translation to viable commercial enterprises in the Australian manufacturing ecosystem.

1.2. About this Report

1.2.1. Purpose

The purpose of this report is to present a comprehensive view of findings from the extant academic literature.

1.2.2. Scope

This report presents a summary of the major themes from a sample of 105 academic journal articles.

2. Analysing the Current Academic Literature

2.1. Approach

The report findings derive from a Systematic Literature Review (SLR) methodology, as Figure 2 illustrates. The analysis focuses on themes related to:

1. Institutional reform and culture change; and
2. Intellectual property and commercialisation.

To define the scope of the search, the report draws on three main research questions to define search strings. These are:

1) How have university-industry collaborations evolved, and what factors influence their effectiveness?

Search Strings: TS=((universit* NEAR/5 industr*) AND (collaborat* OR partner*) AND (evolution OR trend* OR chang*) AND (effective* OR success* OR impact*) AND (commerciali* OR "technology transfer" OR innovat* OR entrepren*))

2) What are the key drivers and barriers to cultural change in universities regarding industry engagement and research commercialisation?

Search String: TS=((universit* OR academi* OR "higher education") AND (cultur* NEAR/5 (chang* OR transform* OR adapt*)) AND (driver* OR barrier* OR enabler* OR challenge* OR factor*) AND (industr* NEAR/5 (engage* OR collaborat* OR partner*)) AND (commerciali* OR "technology transfer" OR "knowledge transfer" OR innovat*) OR ("institutional change" AND (universit* OR academi*) AND (industr* OR business*)))

3) How do institutional policies and initiatives influence academic engagement with industry and research commercialisation?

Search String: TS=((universit* OR academi*) AND (polic* OR initiative*) AND (industr* NEAR/5 (engag* OR collaborat*)) AND (commerciali* OR "technology transfer") AND (impact* OR outcome*))

The research team searched four major academic databases:

- Scopus
- Web of Science
- ProQuest
- EBSCOhost

To ensure that the academic literature reviews were of high quality, two researchers independently screened the search results. This included the removal of duplicates. The researchers also used the following inclusion criteria:

- Publication date range: 2013 – 2024
- Published in a journal listed on the Australian Business Deans Council (ABDC) Journal Quality List or with a Q1 or Q2 journal ranking.
- Population: Universities, industry partners, researchers, etc.
- Study Characteristics: Peer-reviewed journal articles.

The researchers also used the following exclusion criteria:

- Population: K-12 institutions, non-research nonprofits, etc.
- Intervention/Exposure: Purely academic research or corporate R&D without academic involvement.
- Outcome: Irrelevant outcomes or methodological flaws.
- Study Characteristics: Non-English publications, opinion pieces, etc.

A complete list of articles used in the literature review appears in ANNEX B: Bibliography.

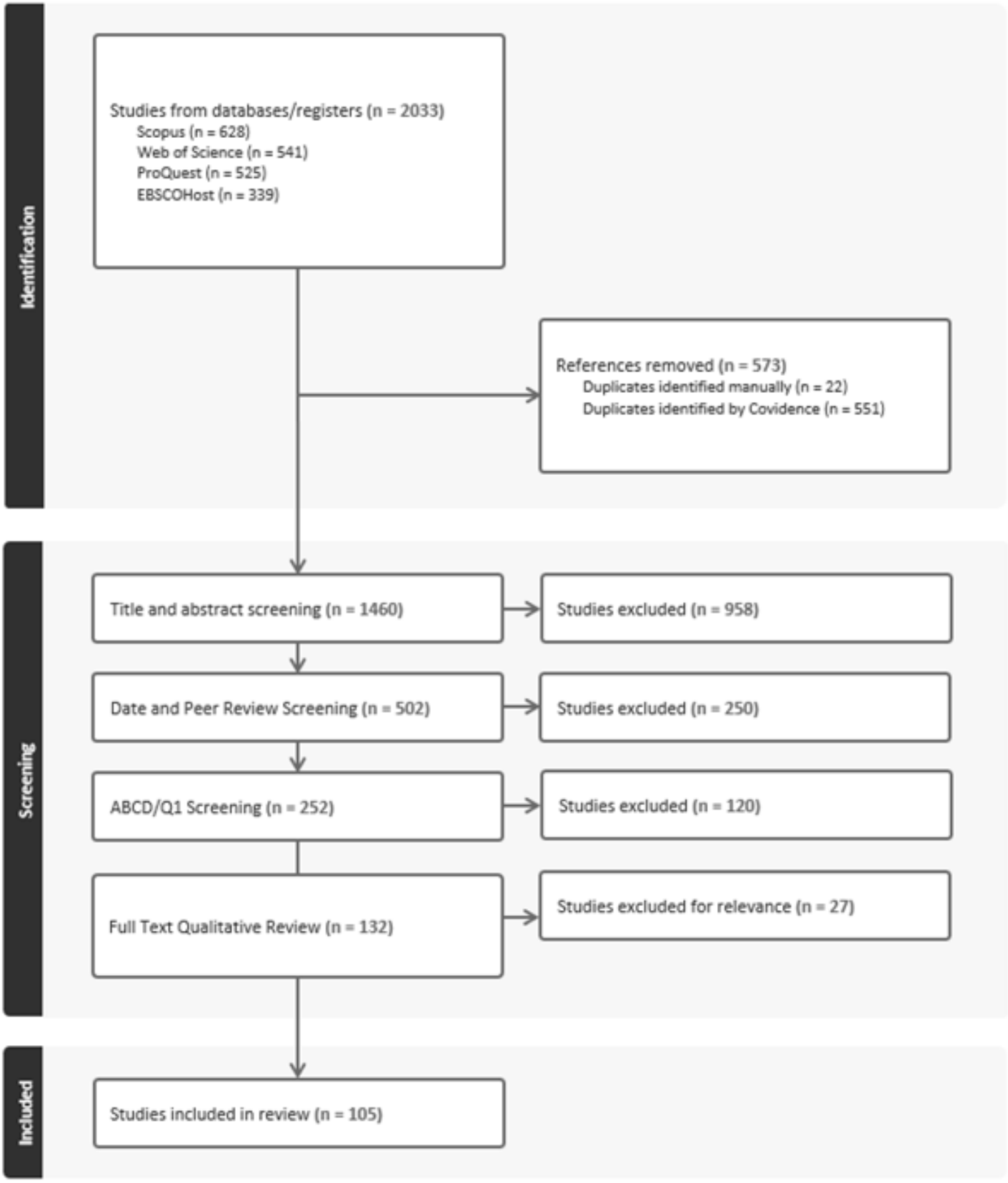

Figure 2: The SLR Methodology

The research team used NVivo version 21 Qualitative Software to conduct a thematic analysis of the 105 academic studies. The findings draw on a narrative literature review approach, and hence reflect subjective interpretations. The research team chose this approach since it led to highlighting key areas of interest to DTB. The initial coding process centred on the following themes for each article:

- Focus area
- Methodology
- Level of analysis
- Enablers
- Barriers
- Interventions
- Outcomes.

2.2. Key Literature Themes related to Institutional Reform and Culture Change

University culture is a multifaceted concept that encompasses the shared values, beliefs, and norms of the academic community. Fostering an entrepreneurial culture within universities is crucial for effective engagement with industry and the commercialisation of research. This cultural shift involves encouraging academics to consider the practical applications and commercial potential of their research, promoting risk-taking and innovation, and valuing engagement with external partners. Universities are implementing various initiatives to nurture this culture, such as entrepreneurship education programs, innovation competitions, and startup incubators. An entrepreneurial culture also creates an environment where failure is seen as a learning opportunity rather than a career setback, encouraging academics to explore novel ideas and collaborations.

In the context of UICs, the key findings highlight the critical role of aligning institutional goals, values, and processes with industry needs, in order to foster a culture of collaborative innovation. Efficient and adaptable university processes, such as streamlined bureaucratic procedures, clear intellectual property management guidelines, and effective technology transfer offices, are essential for facilitating successful UICs.

Furthermore, the attitude of university leaders and the prevailing social norms within the institution significantly impact the success of UICs. Universities that actively promote and reward collaboration with industry, fostering a positive attitude towards UICs, are more likely to create a supportive culture. Building trust and mutual understanding is also essential for successful UICs. Universities that prioritise open communication, transparency, and developing shared goals and objectives with industry partners are more likely to foster a culture of collaborative innovation.

This section summarises macro, organisation, team and individual-level factors that affect university culture in relation to UICs.

2.2.1. Macro Level

A supportive policy environment is a critical foundation for successful UICs. National policies and government initiatives can significantly influence the propensity of universities and industries to engage in collaborative innovation (Jonsson et al., 2015). This is because government policies often shape the broader context in which UICs operate, including funding mechanisms, intellectual property frameworks, and the overall innovation ecosystem (Jonsson et al., 2015).

Effective policies create an enabling environment by addressing key issues such as intellectual property rights, funding mechanisms, and incentives (Fan et al., 2019). For example, policies that allow universities to retain ownership of intellectual property from government-funded research can encourage commercialisation. Similarly, tax incentives for companies investing in university research or matching fund programs can stimulate industry engagement (Bodas Freitas et al., 2013). Inconsistent or inadequate policies may lead to disparities in the effectiveness of collaborations across different regions (Chen and Shang, 2023; Chen et al., 2024). As such, these policies need to strike a balance between protecting public interest and providing incentives for private sector involvement. Lack of government support is a barrier to engagement with industry and the commercialisation of research (Mascarenhas et al., 2022).

The literature increasingly recognises that successful commercialisation depends on complex ecosystem interactions rather than isolated policy interventions. Recent research emphasises how factors like industry maturity, market readiness, and access to investment capital collectively influence commercialisation success rates (Fan et al., 2019).

Contemporary research reveals an evolving understanding of how proximity influences commercialisation success (Rossi, 2024). While traditional literature emphasised geographic co-location, newer studies highlight the growing importance of other proximity dimensions (Rossi, 2024; Kunttu, 2019; Ulhøi, 2012). The understanding of proximity's role in UIC commercialisation has evolved significantly. While geographic proximity remains relevant, research reveals a more complex picture. Studies show that cognitive proximity (shared knowledge bases and expertise) and social proximity (trust-based relationships) can be equally or more important than physical location (Rose and Bharadwaj, 2023; Rossi et al., 2024).

Digital transformation has enabled new forms of collaboration and knowledge exchange, creating opportunities for real-time partnership

across distances (Rossi, 2024). However, this evolution brings fresh challenges around virtual IP protection and cross-jurisdictional data ownership. The rise of digital collaboration tools and virtual research environments is further challenging traditional notions of proximity. While research suggests that technology can bridge physical distances, successful commercialisation still benefits from some form of "proximity" – whether this means shared technical language, complementary organisational cultures, or aligned strategic goals. This more nuanced understanding of proximity has important implications for how UICs are structured and supported.

Lastly, Veletanlić and Sá (2019) emphasise that successful commercialisation requires addressing both 'operational barriers' – like IP negotiations and tensions between basic/applied research – and broader systemic factors that shape actor motivations and goals.

Key Findings:

- Policy frameworks significantly influence but do not determine commercialisation outcomes.
- Effective commercialisation requires coordinated support across the innovation ecosystem.
- Traditional concepts of proximity are being redefined by new collaboration patterns.
- Digital transformation is creating both opportunities and challenges for IP management.
- Policy effectiveness depends heavily on alignment with institutional incentives and actor motivations.

2.2.2. Organisational Level

For UICs to be successful, strong institutional support is required. Universities that have a strong track record of engaging with industry partners and have established clear processes and structures for managing these collaborations are more likely to foster a culture of collaborative innovation (Miller et al., 2014). This is because institutional support provides a foundation for trust and mutual understanding between universities and industries, facilitating the alignment of goals and expectations (Jonsson et al., 2015).

Institutional Goals: The success of UICs is influenced by the alignment of institutional goals. Universities that prioritise knowledge transfer, commercialisation, and societal impact are more likely to foster a culture that supports UICs. This is because these goals encourage academics to view collaboration with industry as a valuable and rewarding activity (Perkmann et al., 2021).

Institutional Values: The values of a university play a crucial role in shaping the culture and success of UICs. Universities that value both academic excellence and entrepreneurial engagement are more likely to foster a collaborative environment. This is because these values create a balance between the pursuit of knowledge and the practical application of research, encouraging academics to view collaboration with industry as a means of achieving both academic and societal impact (D'Este and Patel, 2007).

University Processes: Efficient and adaptable university processes are essential for facilitating successful UICs. Universities that have streamlined bureaucratic procedures, clear guidelines for intellectual property management, and effective technology transfer offices are more likely to foster a culture of collaborative innovation. This is because these processes create a more welcoming and efficient environment for UICs, encouraging greater participation and innovation (Jonsson et al., 2015).

Resources and Capabilities: The availability of resources and capabilities significantly influences the success of UICs. Universities that invest in research infrastructure, specialised equipment, and expertise relevant to industry needs are more likely to attract and engage industry partners. This is because these resources and capabilities enhance the university's value proposition for collaboration, making it a more attractive partner for industry (Jonsson et al., 2015).

Knowledge Transfer and Absorptive Capacity: Effective knowledge transfer mechanisms and the development of absorptive capacity are crucial for successful UICs. Universities that prioritise clear communication channels, knowledge sharing platforms, and training programs to enhance the absorptive capacity of both academics and industry partners are more likely to foster a culture of collaborative innovation. This is because these mechanisms facilitate the exchange of knowledge and ideas,

promoting greater understanding and mutual learning between universities and industries.

Institutional Attitude towards UIC and Social Norms: The attitude of university leaders and the prevailing social norms within the institution can significantly impact the success of UICs (Asman et al., 2018). Universities that actively promote and reward collaboration with industry, fostering a positive attitude towards UICs, are more likely to create a supportive culture. This is because these attitudes and norms shape the behaviour and perceptions of academics, encouraging them to view collaboration with industry as a valuable and rewarding activity (Gerbin and Drnovsek, 2015, 2020). Studies have shown the importance of not only prioritising industry engagement, but also consistently communicating, supporting and rewarding such practices (Gerbin, 2020; Asman, 2018; Acworth, 2008). Newsletters, online platforms, rewarding systems, webinars, workshops, site visits, guest presentations are some of the ways universities communicate their commitment to industry engagement to create social norms.

Trust and Understanding: Building trust and mutual understanding is essential for successful UICs. Universities that prioritise open communication, transparency, and the development of shared goals and objectives with industry partners are more likely to foster a culture of collaborative innovation. This is because trust and understanding facilitate smoother interactions, reduce conflicts, and promote a sense of partnership between universities and industries.

Developing Entrepreneurial University Cultures: Universities have long been recognised for their dual missions of teaching and research. However, in the evolving landscape of higher education and economic development, a third mission has emerged: entrepreneurship (Taxt, 2023; Alexander, 2015; Pitt, 2020; Guerrero, 2019; Wakkee, 2019). This mission emphasises the role of universities in fostering innovation, supporting the commercialisation of research, and engaging with industry to drive economic and social progress (Guerrero et al., 2015). This is also relevant to understanding the changing culture of UICs.

Several studies in this literature review discussed "entrepreneurial universities" in relation to UICs (Alexander et al., 2015; Bojko et al., 2020; Dalmarco et al., 2018; Gaspar Pacheco et al., 2024; Leišytė and Sigl, 2018; Neves and Brito, 2020; Pitt et al., 2020; Schaeffer et al., 2021; Wakkee et al., 2019). An entrepreneurial university is an institution that goes beyond its traditional missions of teaching and research to actively promote and support entrepreneurship within its academic community. It fosters a culture of entrepreneurship by establishing formal institutional structures, such as technology transfer offices, entrepreneurship centres, and incubator programs, to support the commercialisation of research outcomes. Entrepreneurial universities also implement policies and initiatives that encourage academics to engage in entrepreneurial activities, such as flexible intellectual property policies, conflict-of-interest policies, and reward structures (Alexander et al., 2015; Bojko et al., 2020; Dalmarco et al., 2018; Gaspar Pacheco et al., 2024; Leišytė and Sigl, 2018; Neves and Brito, 2020; Pitt et al., 2020; Schaeffer et al., 2021; Wakkee et al., 2019).

- Technology Transfer Office (TTO) support: A well-functioning TTO that actively promotes entrepreneurship, provides training, and facilitates connections with industry is crucial for encouraging entrepreneurial behaviour. The main entrepreneurial structure within a university that facilitates entrepreneurial activities as described by Etskowits (2008) is the "Technology Transfer Office (TTO)." They highlight the importance of TTOs in providing resources and support for entrepreneurial activities (Dalmarco et al., 2018).

- Supportive institutional policies: University policies that incentivise entrepreneurship, such as flexible intellectual property policies, conflict-of-interest policies, and reward structures, contribute to a positive entrepreneurial environment. Yoshioka-Kobayashi (2019) examines the role of institutional factors in fostering academic entrepreneurship, specifically within the context of publicly owned universities in Japan. The paper suggests that despite regulatory constraints faced by publicly owned universities, proactive institutional efforts can effectively promote academic entrepreneurship and enhance spin-off creation. The University of Tokyo achieved this by establishing an incubator, providing early-stage investment resources, and initiating a non-degree entrepreneurship education program.

Yoshioka-Kobayashi (2019) emphasises the importance of balancing the fulfillment of traditional academic roles with the drive for

innovation. The University of Tokyo introduced an academic and commercial bicultural system that allowed both academic research and entrepreneurial actions to coexist, mitigating potential internal cultural conflicts. The paper suggests that publicly owned universities can foster academic entrepreneurship and spin-off creation through proactive institutional efforts, such as establishing incubators, providing investment resources, and implementing entrepreneurship education programs.

Yoshioka-Kobayashi (2019) highlights the importance of "accepting equity as a license royalty" as a driver of entrepreneurship. This is where universities accept shares in a spin-off company as payment for licensing their intellectual property, instead of traditional monetary royalties. This approach benefits both the university and the spin-off company. The university gains a potential financial stake in the company's success, while the spin-off company can conserve cash flow and reinvest it in its growth and development.

- Entrepreneurial university ecosystems: Universities that foster a culture of entrepreneurship through various initiatives, such as entrepreneurship centres, incubator programs, and seed investment funds, create an enabling environment for the commercialisation of research outcomes (Cunningham, 2020; Schaeffer, 2021; Yoshioka-Kobayashi, 2019). Their intention is for knowledge developed within the university to reach society and for that knowledge to then be turned into economic wealth. This emphasises the role of universities in fostering entrepreneurship within a broader ecosystem.
- Scientific research: The quality and focus of the university's scientific research influence the potential for entrepreneurial activities. Universities with a strong research base in applied sciences and close ties with industry are more likely to generate successful entrepreneurial ventures (Gaspar Pacheco et al., 2024). Gaspar Pacheco (2024) states that "the stronger the academics' promotion focus (maximal goals), the stronger their intentions to engage in formal (technology licensing and venture creation) and informal (collaborative research, contract research, consultancy) activities." This underscores the role of scientific research in driving entrepreneurial activities within universities.
- Culture: The overall culture of the university, including attitudes towards entrepreneurship, the presence of role models, and the acceptance of risk-taking, significantly influences the entrepreneurial behaviour of individuals within the institution. Cunningham (2020) discusses the role of culture in shaping entrepreneurial behaviour. The authors state that "universities need to become entrepreneurial organisations, and members must become entrepreneurs that display entrepreneurial patterns." This emphasises the role of culture in creating an enabling environment for entrepreneurship within universities while developing entrepreneurial skills in academics (Cunningham, 2020; Schaeffer, 2021; Yoshioka-Kobayashi, 2019).

Key Findings:

- Universities with a strong track record of industry engagement, established processes, and clear structures foster collaborative innovation by building trust and aligning expectations with industry partners.
- UIC success is influenced by the alignment of institutional goals with knowledge transfer, commercialisation, and societal impact. Universities that value both academic excellence and entrepreneurial engagement create a balanced environment conducive to collaboration.
- Investing in research infrastructure, specialised equipment, and industry-relevant expertise enhances a university's value proposition and attracts industry partners.
- Effective communication channels, knowledge sharing platforms, and training programs facilitate knowledge exchange and mutual learning between universities and industries, fostering collaborative innovation.
- Active promotion and reward of industry collaboration cultivates

a supportive culture. Consistent communication reinforces the commitment to industry engagement and shapes positive social norms. Open communication, transparency, and shared goals foster trust and mutual understanding between universities and industries.

- Universities are increasingly embracing entrepreneurship as a core mission, fostering innovation, supporting commercialisation, and driving economic and social progress through industry engagement. This involves:
  - Establishing formal structures like TTOs, entrepreneurship centres, and incubator programs.
  - Implementing supportive policies and initiatives that incentivise entrepreneurship, such as flexible intellectual property policies and reward structures.
  - Creating a culture of entrepreneurship through initiatives like entrepreneurship centres, incubator programs, and seed investment funds.
  - Focusing on applied sciences and building strong ties with industry.
  - Fostering a university culture that values and supports entrepreneurship, including providing role models and accepting risk-taking.

2.2.3. Team Level

The team level encompasses the composition and dynamics of research groups, the role of TTOs, and the involvement of departments and research centres. Each of these facets contributes to shaping the culture and success of UICs (Gerbin, 2020; Dolmans, 2021; Wang, 2022; Chen, 2024).

Composition and Dynamics: The composition of teams significantly influences IP management and commercialisation success (Cunningham et al., 2014). Teams that effectively combine academic and commercial expertise can enhance commercialisation but require specific support and development (Cunningham et al., 2014).

TTOs: TTOs are crucial in facilitating the commercialisation of research and navigating complex IP processes (Gerbin, 2020; Dolmans, 2021; Wang, 2022; Chen, 2024). They act as intermediaries between universities and industry, facilitating communication, identifying commercially viable research, and managing IP negotiations (Wang and Liu, 2022). However, their effectiveness depends on institutional support, resources, and expertise.

Studies argue that academics often hold mixed views on the role of TTOs. Some appreciate their support in commercialisation and IP management, while others perceive them as bureaucratic or overly focused on financial returns, potentially hindering academic freedom and curiosity-driven research (Taxt, 2023).

Barriers and Facilitators for TTO work:

- Barriers: Lack of resources, bureaucratic processes, over-projections in expected income from the commercialisation projects and misalignment of incentives can hinder the effectiveness of TTOs.
- Facilitators: Strong institutional support, clear IP policies, and a collaborative culture can facilitate TTO work.

Departments and Research Centres: Departments and research centres also play a crucial role in supporting UICs, particularly by enabling multidisciplinary collaboration and resource acquisition (Dolan et al., 2019). They can foster an environment conducive to innovation and knowledge transfer by promoting interdisciplinary research initiatives and providing access to specialised equipment and facilities (Dolan et al., 2019).

Key Findings:

- The composition of teams significantly influences IP management and commercialisation success.
- TTOs are crucial in facilitating the commercialisation of research and navigating complex IP processes.
- Departments and research centres play a crucial role in supporting UICs by enabling multidisciplinary collaboration and resource acquisition.

2.2.4. Individual level

The individual level factors, such as the academics' motivations, opportunities, and capabilities, play a significant role in creating a culture that supports UICs (Acworth, 2008; Filieri, 2014; Cunningham, 2020; Gerbin, 2020; Dolmans, 2021; Lee, 2014). These factors influence academics' willingness and ability to engage in collaborative research and commercialisation activities (Arshed, 2021; Taxt, 2023; Gerbin, 2020; Dolmans, 2021; Perkmann et al., 2021). For instance, academics who are motivated by the potential for societal impact or have strong boundary-spanning capabilities are more likely to actively participate in UICs (Dolmans, 2021; Perkmann et al., 2021).

Intrinsic motivation is self-driven behaviour motivated by an internal reward. It is typically what drives academics to engage in university-industry collaborations Academics are often intrinsically motivated by intellectual curiosity, research prestige, desire to contribute to knowledge, societal impact, career advancement, access to resources (both financial and in-kind), and the desire for recognition and esteem (D'Este et al., 2019). On the other hand, industry professionals tend to be more extrinsically motivated by profit margins, market competitiveness, and practical applications. This motivational gap may reduce the overall effectiveness of the collaboration, as both parties may not fully commit to the same goals.

Extrinsic motivation plays a role in academic entrepreneurship. Extrinsic motivation is driven by external rewards, such as money or recognition. For example, D'Este and Perkmann (2011) found that academics are primarily driven by personal payoffs in patenting and spin-off creations.

However, research consistently challenges the traditional assumption that financial rewards are the primary driver for academic engagement in commercialisation. While financial incentives play a role, studies reveal a rich tapestry of motivations that influence academics' decisions to engage with industry. Career advancement and research enhancement emerge as significant motivators, with academics viewing industry engagement as a means to advance their research capabilities through access to industry data, equipment, real-world testing environments, future research funding opportunities and faster feedback loops on research validation. For example, Hayter (2011) found that academics are 7.4 times more likely to create a spin-off company if they expect it to enhance their career success.

Early career academics may face unique challenges and motivations in engaging with UICs. They may be driven by the need to establish their research reputation, secure funding, and gain practical experience. EICs may also lack the social capital and networks that can facilitate collaboration with industry.

Studies show that seniority, professional reputation, and social capital significantly influence the success of collaborations. Seniority, academic prestige and prior collaboration experience are critical, as established academics possess greater resources, networks, and credibility, making them desirable partners for industries seeking legitimacy in their research and development initiatives (Eom & Lee, 2010).

Individuals with strong professional and personal networks seem to leverage these connections to access resources, expertise, and support, which can benefit the collaborative project. Established networks of academics – as well as industry support, which builds trust and fosters a sense of reciprocity among the individuals involved – were identified as crucial for establishing a strong and productive collaborative relationship (Chen and Shang, 2023; Eom & Lee, 2010).

Research shows that individuals with a positive attitude towards collaborative work, who value the contributions of others and embrace knowledge sharing, are more likely to foster a productive and successful partnership (Chen and Shang, 2023). Furthermore, clear and open communication is essential for successful collaboration. Individuals should be able to effectively convey their ideas, actively listen to others, and engage in constructive dialogue to facilitate knowledge sharing and problem-solving (Chen and Shang, 2023).

The ability of partners to learn about and understand one another is essential for a successful collaboration (Hadjimanolis, 2006). This highlights the importance of listening, and negotiation skills of boundary spanners – such as business development managers, industry engagement officers and contract negotiators – for the success of an entrepreneurial university culture.

In the context of UICs, academics are often required to act as boundary spanners, facilitating knowledge transfer between two distinct domains. Dolmans et al. (2021) found that academics develop boundary-spanning abilities over time by engaging in perspective-taking. Perspective-taking enables academics to understand the knowledge boundaries between academia and industry. By understanding these boundaries, academics can more effectively transfer knowledge across them.

Prior experience as an academic collaborating with industry and/or previous experience working in the industry have positive effects on intention to collaborate, and patenting (Goel and Goktepe-Hulten, 2013). Academics and industry professionals who have had positive experiences with collaborative research or commercialisation activities are more likely to engage in future partnerships. This is because prior experience can foster trust, provide valuable insights, and enhance the skills and capabilities necessary for successful collaboration.

Interventions to promote individual-level engagement:

- Mentorship programs to connect early career academics with experienced collaborators.
- Training programs to develop boundary-spanning capabilities and commercialisation skills.
- Incentive schemes to reward and recognise successful UIC engagement.

An entrepreneurial academic is a member of the academic community who actively participates in the commercialisation and transfer of their research to industry. They move beyond their traditional roles of teaching and research to proactively engage in activities that promote the economic and societal impact of their scientific discoveries. Entrepreneurial academics may be involved in various activities, such as patenting and licensing their inventions, creating spin-off companies, and collaborating with industry partners (Alexander et al., 2015; Bojko et al., 2020; Dalmarco et al., 2018; Gaspar Pacheco et al., 2024; Leišytė and Sigl, 2018; Neves and Brito, 2020; Pitt et al., 2020; Schaeffer et al., 2021; Wakkee et al.,

2019). Literature discusses the following factors relating to entrepreneurial academics:

- Past entrepreneurial experience: Prior involvement in entrepreneurial activities positively influences entrepreneurial intentions and the ability to identify new market opportunities. Previous entrepreneurial and industrial experience positively impacts an academic's knowledge valorisation intentions (Neves and Brito, 2020). They cite Obschonka et al. (2015), who emphasise the fundamental role of past entrepreneurial behaviour in shaping intentions to create spin-offs. Many scientists change between employment at universities and start-ups quite frequently, especially if they had reasons to expect that the start-up would not be a sustainable success (Leišytė and Sigl, 2018). This highlights the importance of prior experience in shaping entrepreneurial intentions and behaviours.
- Entrepreneurial self-efficacy: Individuals with a strong belief in their ability to succeed in entrepreneurial activities tend to exhibit more entrepreneurial behaviour (Son et al., 2019). The authors found that PROs with higher entrepreneurial self-efficacy are more reluctant to establish spin-offs with technologies created using private firms' funds. This underscores the role of self-belief in driving entrepreneurial behaviour.
- Risk-taking propensity: The willingness to take risks is a key entrepreneurial trait. Individuals with a higher risk-taking propensity are more likely to identify and exploit entrepreneurial opportunities. Neves and Brito (2020) emphasise the importance of risk-taking propensity as a personal motivation that drives entrepreneurial intentions. They note that "academics' risk-taking propensity... on different knowledge valorisation activities" is an important factor in shaping entrepreneurial behaviour (Neves and Brito, 2020). This highlights the role of risk-taking in driving entrepreneurial activities within academia.
- Puzzle-solving motivation: The intrinsic motivation to apply knowledge, driven by curiosity and a desire to solve problems, is a significant driver for scientists to commercialise their research. Neves and Brito (2020) note that "academics often consider spin-offs to be a platform that provides access to fund research." They also highlight that "academics are equally driven by utilitarian reasons" such as obtaining tangible resources. This underscores the role of both intrinsic motivation and practical considerations in driving academic entrepreneurship (Bojko et al., 2020).
- Access to networks: Having a network of mentors, advisors, and role models positively influences entrepreneurial intentions and provides support for navigating the entrepreneurial journey. Blankesteijn et al. (2020) highlight the importance of networks and social capital in influencing entrepreneurial intentions. The authors found that "the engagement of students in the whole [innovation] chain leads them to create opportunities" (Blankesteijn et al., 2020). This emphasises the role of social support and networks in fostering entrepreneurial behaviour.

Key Findings:

- Individual characteristics beyond academic position significantly influence commercialisation engagement, with prior experience, established networks and boundary-spanning capabilities being crucial success factors.
- Motivation for commercialisation extends well beyond financial incentives and varies by discipline and career stage, with societal impact, research enhancement and academic prestige being powerful drivers.
- Systemic gender barriers persist in UICs, reflected in approximately 10 per cent lower engagement rates for women-led research groups and compounded by career stage challenges and institutional structures.
- The development of individual boundary-spanning capabilities emerges as critical for successful commercialisation, requiring targeted support mechanisms throughout the careers of researchers.

2.2.5. Cross level interactions and relationships

A deeper level of analysis involves examining the cross-level interactions between the macro, organisational, and individual levels. These levels do not operate in isolation but rather influence each other in complex ways (Miller et al., 2018). For instance, a supportive macro-level policy environment encourages universities to develop organisational structures and processes that facilitate greater engagement with industry at the individual level (Jonsson et al., 2015).

Fan et al. (2019) noted that government funding had a significant positive effect on the implementation of UIC regulations and the innovation climate within universities. This highlights how macro-level policies (government funding) can influence organisational-level factors (implementation of regulations and innovation climate) (Fan et al., 2019).

Ulhøi et al. (2012) emphasised the importance of boundary spanners in facilitating knowledge transfer between universities and SMEs. These individuals, who often have experience in both academia and industry, can help to bridge the gap between the two sectors and promote greater understanding and collaboration.

Plantec et al. (2023) highlighted the critical role of PhD supervisors in shaping the research orientation and performance of collaborative PhD projects with industry. This illustrates how individual-level factors (supervisor's guidance and mentorship) can influence the success of team-level collaborations (PhD projects with industry).

These examples demonstrate the complex interplay between macro-level policies, organisational support, team-level dynamics, and individual motivations in shaping the success of UICs. These interactions between different levels form feedback loops, where successes or failures at one level impact others. For example, an individual researcher's successful collaboration with industry can serve as a model that reinforces organisational support for UICs, potentially influencing incentive structures or strategic goals. Conversely, conflicting organisational values or restrictive policies at the macro level can limit individual engagement, decreasing motivation and reducing the quality of partnerships. Successful UICs, therefore, depend on a dynamic interplay where macro-level policies encourage organisational support, team-level boundary spanners bridge gaps, and individual motivations align with the broader collaborative goals.

Key Findings:

- Success in IP management and commercialisation requires alignment across all levels.
- Misalignment at any level can create ripple effects that impact overall effectiveness.
- Trust development and resource flows operate as critical cross-level mechanisms.
- Individual capabilities must be supported by appropriate organisational structures.
- Sustainable commercialisation success depends on coordinated support across levels.

Table 2 provides a summary of the main themes relating to Institutional Reform and Culture Change.

Table 2: Main themes relating to Institutional Reform and Culture Change

Level of Analysis	Theme	Sub-Themes and Variables	Literature Contributions	Exhibits As
Macro	Government and policy influence	IP Policies; funding mechanisms; collaboration incentives	Etskowits and Leydesdorff (2000); Fitsgerald and Cunningham (2016); Mowery et al. (2001); Bodas Freitas et al. (2013); Aiello et al. (2019); Chen et al. (2016)	Government policies shape incentives; regional collaboration effectiveness
Organisational	Institutional goals	Academic vs. commercial goals; IP secrecy issues	Florida and Cohen (1999); Dudkowski (2021); Mowery and Sampat (2005); Cunningham et al. (2016)	Tension between academic openness and industry confidentiality; affects research direction and timelines
	Institutional values	Knowledge sharing vs. market-driven outcomes; timeline discrepancies	Santoro and Chakrabarti (1999); Pavitt (2005); Sjöö and Hellström (2019); Marinho et al. (2020)	Conflicting values on knowledge dissemination and commercialisation; friction in project timelines
	University processes	Bureaucracy; decision-making speed; IP management; contract negotiation; incentives	Boardman and Boseman (2015); Schofield (2013); Rybnicek and Königsgruber (2019); Halilem et al. (2017); Goel and Goktepe-Hulten (2018); Bercovits and Feldman (2006)	Slow academic processes hinder agile industry needs; IP ownership disputes; differing incentive structures
	Resources and capabilities	Availability of research facilities; expertise; funding support	Cunningham et al. (2015); Miller et al. (2016); Fontana et al. (2006); Arvanitis et al. (2008); Giuliani and Arsa (2009); Hemert et al. (2013)	Imbalance in resource availability and quality; unequal contribution affects collaboration outcomes
	Knowledge transfer and absorptive capacity	Absorptive capacity of industry partners; knowledge integration	Badillo et al. (2017); Bodas Freitas et al. (2013)	Disparities in absorptive capacity impact knowledge exchange and practical application
	Institutional attitude and social norms	Attitudes toward industry engagement; peer influence	Tartari et al. (2014); Aschhoff and Grimpe (2014); Ding and Choi (2011); Slavtchev (2013)	Attitudes toward collaboration vary; peer influence and social norms shape engagement levels
	Trust and understanding	Mutual understanding; communication barriers	Sjöö and Hellström (2019); Rybnicek and Königsgruber (2019); Marinho et al. (2020); Tereshchenko et al. (2024)	Mistrust due to different operational cultures; lack of shared objectives and understanding
	Entrepreneurial university	Universities third mission; Entrepreneurial university ecosystems; fostering an entrepreneurial mindset and skills development; supporting policies and infrastructure; networking; scientific research; TTOs	Alexander et al. (2015); Bojko et al. (2020); Dalmarco et al., (2018); Gaspar Pacheco et al. (2024); Leišytė and Sigl (2018); Neves and Brito (2020); Pitt et al. (2020); Schaeffer et al. (2021); Wakkee et al. (2019).	
Team	Boundary spanning teams	TTOs; Industry liaison roles	Alexander et al. (2015); Chapple et al. (2005); Siegel et al. (2007); Muscio (2010); Ponomariov (2008); Fini et al. (2010); Abreu and Grinevich (2013)	Teams bridging academia and industry are essential for effective collaboration
Individual	Motivation	Academic vs. industry motivations, social norms; attitudes; awareness	Vick and Robertson (2018); Aiello et al. (2019)	Academics prioritise research; industry seeks profit-driven outcomes
	Opportunities	Seniority; networks; prior experience; work schedules	Lee (1996); Aiello et al. (2019); Eom and Lee (2010); Rampersad (2014)	Senior, well-connected academics enhance collaboration through reputation and network access
	Personality	Adaptability; open communication		
	Capability	Skills for cross-sector communication; boundary spanning; knowledge; entrepreneurial self-efficacy; risk-taking propensity; puzzle-solving motivation	Logar et al. (2001); Barnes et al. (2002); Hadjimanolis (2006); Ryan (2007; Goel and Goktepe-Hulten (2013); Tartari et al. (2012), (Arshed, 2021; Taxt, 2023; Gerbin, 2020; Dolmans, 2021; Perkmann et al., 2021).	Relevant skills in communication and project management enhance collaboration effectiveness; Individuals with adaptable personalities and communication skills foster better collaboration

2.3. Key Literature Themes on Intellectual Property and Commercialisation

In examining UICs, intellectual property (IP) and commercialisation represent critical elements that influence partnership success. The literature reveals multiple interacting factors that shape how universities and industry partners manage IP and achieve commercialisation outcomes.

2.3.1. Macro-Environmental Level

At the macro-level, government policies and legislative frameworks significantly influence IP management and commercialisation success in UICs. Studies consistently show that regulatory environments shape not only formal IP ownership and rights allocation, but also the broader ecosystem required for effective commercialisation. Research emphasises the critical role of aligned policy frameworks that support both technology transfer mechanisms and innovation system development (Chapple et al., 2005, Wang and Liu, 2022, Veletanlić and Sá, 2019). For instance, a study examining the impact of government funding on academic-industry partnerships in Denmark found that funding can influence firms' innovation behaviour differently depending on the type of firm, highlighting the need for tailored policies that consider firm-specific characteristics and the broader innovation ecosystem (Cohen et al., 2020).

Multiple studies highlight how policy effectiveness varies across contexts, often due to misalignment between policy intentions and institutional incentives. This misalignment can manifest in metrics that prioritise quantity over quality of commercialisation outcomes, or frameworks that fail to account for sector-specific needs (Ankrah et al., 2013, Son et al., 2019, Wirsich et al., 2016). A study analysing Canadian government programs for university-industry partnerships revealed misalignments between the programs' goals and the incentives for academic researchers and industry partners, resulting in the displacement of macro-level policy goals (Guerrero et al., 2021). The study highlights the importance of considering the institutional context and aligning incentives to achieve policy objectives.

The literature increasingly recognises that successful commercialisation depends on complex ecosystem interactions rather than isolated policy interventions. Recent research emphasises how factors like industry maturity, market readiness, and access to investment capital collectively influence commercialisation success rates. Studies demonstrate that stronger IP enforcement frameworks, when combined with supportive ecosystem elements, significantly improve technology transfer outcomes (Chapple et al., 2005, Wang and Liu, 2022, Veletanlić and Sá, 2019).

Contemporary research reveals an evolving understanding of how proximity influences commercialisation success. While traditional literature emphasised geographic co-location, newer studies highlight the growing importance of other proximity dimensions. The understanding of proximity's role in UIC commercialisation has evolved significantly. While geographic proximity remains relevant, research reveals a more complex picture. Studies show that cognitive proximity (shared knowledge bases and expertise) and social proximity (trust-based relationships) can be equally or more important than physical location (Maietta, 2015).

For example, research shows that cognitive proximity is lower in social science collaborations compared to natural sciences, as social science knowledge is less codified. This means geographic proximity may be more important for accessing social science research than natural science research. The amount of tacit knowledge also varies throughout a project's lifecycle and is typically higher in early phases, which requires greater affinity between university and industry partners (O'Dwyer et al., 2022, Bojko et al., 2020).

Evidence suggests that successful collaborations often depend more on the strength of relationships and shared understanding than physical distance. Studies indicate that firms within a 150km radius of universities show higher likelihood of product innovation, but this effect is moderated by other factors such as the presence of industry-relevant degree programs that act as knowledge transfer channels, previous collaboration experience between partners, complementary expertise and resources, and the development of mutual trust and understanding (Tootell et al., 2020, Wirsich et al., 2016).

Digital transformation has enabled new forms of collaboration and knowledge exchange, creating opportunities for real-time partnership across distances. However, this evolution brings fresh challenges around virtual IP protection and cross-jurisdictional data ownership (Xing et al., 2024,

Wirsich et al., 2016, Hoppmann, 2021). The rise of digital collaboration tools and virtual research environments is further challenging traditional notions of proximity. However, research suggests that while technology can bridge physical distances, successful commercialisation still benefits from some form of "proximity" – whether this is shared technical language, complementary organisational cultures, or aligned strategic goals (Hoppmann, 2021, Song and Guan, 2024, Plata, 2024).

This more nuanced understanding of proximity has important implications for how UICs are structured and supported. Rather than focusing solely on co-location, successful partnerships increasingly emphasise building multiple forms of proximity through targeted relationship development and capability building activities.

Lastly, Veletanlić and Sá (2019) emphasise that successful commercialisation requires addressing both 'operational barriers' – like IP negotiations and tensions between basic/applied research – and broader systemic factors that shape actor motivations and goals.

Key Findings:

- Policy frameworks significantly influence but do not determine commercialisation outcomes.
- Effective commercialisation requires coordinated support across the innovation ecosystem.
- Traditional concepts of proximity are being redefined by new collaboration patterns.
- Digital transformation is creating both opportunities and challenges for IP management.
- Policy effectiveness depends heavily on alignment with institutional incentives and actor motivations .

2.3.2. Organisational Level

At the organisational level, institutional structures, policies, and culture play crucial roles in enabling or hindering successful IP management and commercialisation. Research reveals significant tension between academic and commercial imperatives that shapes organisational approaches to UICs. Universities traditionally prioritise publishing findings to advance knowledge and support career progression, while industry partners often require confidentiality to protect competitive advantages (Wang and Liu, 2022, Plantec et al., 2023, Kunttu and Neuvo, 2019).

This fundamental tension manifests in several key areas. Universities tend to value long-term research timelines, knowledge dissemination, and theoretical contributions, while industry often prioritises shorter timeframes, application-focused outcomes, and market-driven results. Studies show these differences can create significant friction, as industrial partners expect rapid, actionable results while academic researchers prioritise research depth and rigour (Ulhøi et al., 2012, Kunttu and Neuvo, 2019).

University bureaucratic structures and processes significantly influence UIC success. Research highlights how universities' slow and rigid decision-making processes often conflict with industry's need for agility. This misalignment affects various aspects of collaboration, from contract negotiation to IP management (Mowery and Sampat, 2005). Studies show that when royalty rates set by the university are high, academics may choose alternative routes to commercialisation, such as consulting rather than patenting (Fan et al., 2019, Jonbekova et al., 2020).

TTOs emerge as crucial intermediaries that can have varying degrees of success and efficacy. While TTOs aim to bridge the gap between academia and industry, their success depends heavily on institutional support, resources, and expertise. Research indicates that progressive institutions are incorporating industry collaboration, patents, and knowledge transfer activities into their promotion and tenure criteria, though implementation varies significantly (Jones and Coates, 2020, Alexander et al., 2015). Beyond TTOs, a broader range of organisational factors contribute to the success of IP and commercialisation in UICs. The organisational culture, encompassing shared values, norms, and attitudes towards commercialisation, can significantly impact researchers' incentives and behaviours. Leadership commitment to commercialisation, as demonstrated through resource allocation, strategic planning, and the establishment of reward systems, is also crucial for creating an environment that encourages and supports knowledge transfer activities (Ates et al., 2024, Song et al., 2019)

The development of appropriate organisational capabilities has been shown to be essential. Studies demonstrate that industries' ability to absorb, integrate, and apply academic knowledge varies significantly. Universities with comprehensive support systems that address legal, commercial, and administrative needs show enhanced IP management outcomes (Dalmarco et al., 2018, Fan et al., 2019, Guerrero et al., 2021).

Trust and mutual understanding emerge as fundamental organisational requirements. Research shows that academics and industry professionals often struggle with distinct cultures, languages, and operational structures across different sectors. Successful institutions develop mechanisms for building trust, such as frequent communication, long-term commitment, shared objectives, and transparency in decision-making (Ulhøi et al., 2012, O'Dwyer et al., 2022, Jabbar et al., 2024).

Key Findings

- Organisational cultural alignment and value compatibility significantly impact UIC success, particularly regarding publication freedom versus commercial confidentiality.
- Institutional processes need to balance academic rigour with industry agility, with bureaucracy often hindering collaboration.
- Resource availability and absorptive capacity affect collaboration outcomes, requiring comprehensive support systems.
- Trust development and mutual understanding at the organisational level are fundamental to successful partnerships.
- Progressive reward systems that value industry engagement can help bridge cultural divides.

2.3.3. Inter-organisational Level

The relationship between universities and industry partners presents a dynamic landscape for IP management and commercialisation, ripe with both opportunities and challenges. While these partnerships offer potential for groundbreaking innovations and enhanced competitiveness, they also demand careful negotiation and keen understanding of inherent complexities. Recent research reveals these relationships are increasingly being reshaped by digital transformation, creating new opportunities for real-time collaboration while introducing fresh challenges around virtual IP protection and data ownership (Xing et al., 2024).

A recurring theme in the literature is the inherent tension between the academic pursuit of knowledge dissemination and industry's focus on protecting and commercialising intellectual property. This tension manifests in various ways, from disagreements over IP ownership and publication timelines, to deeper conflicts regarding the role of knowledge creation within society. Studies show that when university royalty rates are high, academics often choose alternative routes like consulting rather than patenting (Wang and Liu, 2022). Moreover, research indicates that industrial partners frequently view universities as overly protective of their IP rights, while institutional bureaucracy can discourage open innovation practices (Alexander et al., 2015, Sharifi et al., 2013, O'Dwyer et al., 2022).

Beyond this fundamental tension, research points to operational challenges at the inter-organisational level. Studies highlight how different institutional incentive systems create barriers to collaboration. Industrial partners carry insurance risks, staff risks, and environmental management risks while investing hard-earned capital, yet academics often do not fully understand these commercial pressures (Bercovits and Feldman, 2007). Evidence suggests successful partnerships often develop concrete actions to motivate collaboration on both sides, such as extending industry incentive systems to cover university staff working on joint projects (Perkmann et al., 2021).

The Triple Helix model of university-industry-government collaboration serves as a vital framework for understanding and potentially enhancing inter-organisational dynamics in IP management and commercialisation (Bronneberg et al., 2023). The model emphasises the importance of aligning the objectives of universities, industry and government to create a collaborative environment conducive to innovation (Bronneberg et al., 2023, Chai and Shih, 2016). Government policies are crucial in enabling these collaborations by addressing IP rights and research funding mechanisms (Oliver, 2022). Strong institutional support within universities, including TTOs and industry

liaison officers, is essential for bridging cultural and operational gaps between academia and industry. However, the Triple Helix model has been criticised for potentially oversimplifying complex relationships and failing to adequately address power imbalances or competing interests among stakeholders (Cai and Amaral, 2021). For example, some argue that the model may not fully capture the nuances of how different disciplines or sectors engage in UICs, or how individual researchers navigate the tensions between academic freedom and commercial pressures. Others suggest that the model may not be universally applicable across different national or cultural contexts, highlighting the need for adaptations and critical reflections when implementing Triple Helix approaches.

At the single institution level, the Triple Helix model can be applied to foster a more collaborative and entrepreneurial culture within the university. By encouraging closer relationships between researchers, industry partners, and government agencies, universities can break down traditional silos and create a more integrated approach to innovation (Oliver, 2022). This can involve establishing clear IP policies that balance academic and commercial interests, developing support structures for technology transfer and commercialisation, and promoting a culture that values both fundamental research and its practical applications..

Key Findings

- Misalignment between academic and commercial priorities can complicate collaborations.
- Conflicting priorities between academia and industry regarding IP ownership, timelines, and open science principles create significant challenges in managing collaborations.
- The Triple Helix model fosters synergy among universities, industry, and government, enhancing innovation through aligned objectives, but it requires critical reflection and adaptation to specific contexts.

2.3.4. Team Level

The literature on UICs acknowledges the influence of team-level factors on IP management and commercialisation, yet this area remains underexplored compared to the individual and organisational levels. While there is a growing recognition of the importance of teams in navigating the complexities of UICs, specific studies focusing on team dynamics and their impact on IP and commercialisation outcomes are limited. Most studies focus on cross-sectional data at project or interorganisational level, with few examining the perspective of both academic and industrial partners at the team level simultaneously (Kusior et al., 2024, Yoshioka-Kobayashi, 2019). This gap may be attributed to the focus on individual and organisational levels, the complexity of team dynamics, and the limited availability of data on team composition and processes within UICs.

Despite this gap, existing research offers valuable insights into the potential influence of team-level factors. Studies emphasise the importance of assembling teams with diverse expertise, combining academic knowledge with commercial experience to effectively manage the commercialisation process. Research shows that project managers are particularly vital in harmonising different objectives, needs, perspectives, and modes of operation between academic and industrial organisations (O'Dwyer et al., 2022). Teams that effectively combine these different perspectives demonstrate enhanced capability for managing the commercialisation process, though they face unique challenges in reconciling different working styles and expectations (Tootell et al., 2020).

The composition of teams is crucial, extending beyond just the core research team. Evidence shows the importance of external engagement teams that bridge cultural and operational gaps between academia, industry and government. TTOs, industry liaison officers, and dedicated project managers act as essential intermediaries, helping to identify commercially viable research and navigate complex IP processes (Wirsich et al., 2016). Moreover, departments and research institutes play a crucial team-level role, particularly in enabling multidisciplinary collaboration and resource acquisition (Wang and Liu, 2022, Kusior et al., 2024).

Effective leadership emerges as particularly critical. Research leaders serve as bridges between academic and commercial worlds,

helping their teams navigate competing demands and maintain productive relationships with industry partners. However, studies indicate many research leaders lack formal training or support in managing these complex relationships (Leišytė and Sigl, 2018). Teams need to develop specific practices to balance competing demands, such as academic publication timelines with commercial confidentiality requirements, while maintaining effective knowledge sharing and collaboration (Lee and Miosso, 2014, Bronneberg et al., 2023).

Despite their crucial role in UICs, team-level factors remain relatively underexplored in the literature compared to individual and organisational dimensions. Most studies focus on cross-sectional data at project or dyadic level, with few examining the perspective of both academic and industrial partners at the team level simultaneously (O'Dwyer et al., 2022). This gap is particularly notable in understanding how team dynamics evolve over time and influence IP management and commercialisation outcomes.

Departments and research institutes also play a crucial team-level role in supporting UICs. Specially designed institutes, such as cooperative research centres, can support academics in leveraging academic engagement for their research, particularly by enabling multidisciplinary collaboration and resource acquisition (Wang and Liu, 2022, Messeni Petrusselli and Murgia, 2021).

Key Findings

- Limited research specifically focuses on team-level factors in IP management and commercialisation within UICs.
- Teams combining academic and commercial expertise can enhance commercialisation but require specific support and development.
- The role of intermediary teams and project managers proves crucial for bridging institutional boundaries.
- Leadership capability at the team level emerges as critical, yet many research leaders lack formal support for managing industry partnerships.

2.3.5. Individual Level

At the individual level, research reveals both enabling factors and persistent challenges in IP management and commercialisation activities. Individual-level factors play a significant role in shaping the landscape of IP management and commercialisation within UICs. These factors encompass a wide range of individual characteristics, motivations, and capabilities that influence how researchers and practitioners engage in collaborative innovation and technology transfer. Understanding these individual-level factors is crucial for promoting successful UICs and maximising the potential for positive outcomes.

Individual-level factors play a significant role in shaping the landscape of IP management and commercialisation within UICs. These factors encompass a wide range of individual characteristics, motivations, and capabilities that influence how researchers and practitioners engage in collaborative innovation and technology transfer. Understanding these individual-level factors is crucial for promoting successful UICs and maximising the potential for positive outcomes (Bojko et al., 2020, Cohen et al., 2020)

One of the key individual-level factors is motivation. Research consistently challenges the traditional assumption that financial rewards are the primary driver for academic engagement in commercialisation. While financial incentives play a role, studies reveal a rich tapestry of motivations that influence academics' decisions to engage with industry (Cohen et al., 2020, Abramo and D'Angelo, 2021, Marullo et al., 2021). Career advancement and research enhancement emerge as significant motivators, with academics viewing industry engagement as a means to advance their research capabilities through access to industry data, equipment, real-world testing environments and faster feedback loops on research validation (Perkmann et al., 2021, Oliver, 2022). The desire to create societal impact represents another powerful motivator, particularly in fields like life sciences, where researchers are strongly motivated by seeing their research translated into practical applications that benefit society (O'Dwyer et al., 2022, Olmos-Peñuela et al., 2016). This motivation often outweighs purely financial considerations, with researchers viewing commercialisation as a pathway to ensure their work reaches beyond academic boundaries to create tangible benefits

(Hoppmann, 2021, Sheng and Hu, 2018, Kusior et al., 2024).

Academic prestige and recognition play a complex role in motivation patterns, with scientists often pursuing industry engagement to gain visibility and prestige, rather than as a goal in itself (Bojko et al., 2020, Alexander et al., 2015, Ulhøi et al., 2012). Learning and knowledge exchange opportunities are increasingly recognised as significant drivers, with academics valuing industry collaboration for gaining insights into practical challenges, understanding industry needs, testing theoretical findings in applied settings and developing new research questions from real-world problems (Kunttu and Neuvo, 2019, Olmos-Peñuela et al., 2016). Studies show these motivation patterns vary across career stages and disciplines – early career researchers may engage to build networks and gain industry exposure, while established academics may be more motivated by opportunities to expand their research impact or mentor younger colleagues (Plantec et al., 2023). This broader understanding suggests universities could better encourage commercialisation by creating diverse pathways for engagement that appeal to different motivational drivers, rather than focusing primarily on financial incentives. This could include recognition systems that value industry engagement, support for impact-focused research, and opportunities for meaningful knowledge exchange and professional development.

Another crucial factor is the development of boundary-spanning capabilities. These capabilities refer to the skills and competencies that enable individuals to effectively navigate and mediate between the different institutional cultures of academia and industry (Chai and Shih, 2016). Individuals with strong boundary-spanning capabilities can facilitate communication, build trust, and manage conflicts, thereby enhancing the likelihood of successful collaborations and positive commercialisation outcomes. These capabilities include strong communication skills across sectors, ability to build trust and personal relationships, understanding of both academic and industry priorities, and the capacity to manage competing demands between knowledge sharing and protection (Tootell et al., 2020).

Gender emerges as a significant systemic barrier in UIC engagement and commercialisation activities, with multiple studies revealing persistent structural challenges. Research demonstrates that gender homophily mechanisms create compounding disadvantages for women academics in developing essential social capital, directly impacting their access to leadership positions, research funding, and industry collaboration networks (Abramo and D'Angelo, 2021, Maietta, 2015). Studies show that research groups led by women have approximately 10 per cent lower probability of engaging in R&D cooperation with firms, while male academics demonstrate significantly higher rates of engagement across multiple commercialisation metrics including publishing books, scientific publications with industry partners, and business idea generation (Abramo and D'Angelo, 2021). The intersection of gender with career stages creates additional complexity, as women often face disproportionate family responsibilities alongside heavier teaching and administrative duties, particularly in early career stages. This challenge is amplified in cross-sector collaborations, where studies indicate women academics engage less in collaboration activities with industry than male colleagues of similar status. While some studies reveal that women's propensity to collaborate may vary more than men's throughout their professional life due to these competing demands (Bojko et al., 2020), the literature on effective interventions remains limited. Recent research emphasises that addressing these disparities requires examining not just individual factors but the broader institutional structures that create and maintain gender-based barriers in UICs, including promotion criteria, networking opportunities, and resource allocation systems (Weerasinghe and Dedunu, 2020, Wirsich et al., 2016).

Prior experience emerges as a significant predictor of successful engagement. Studies demonstrate that previous experience – either as an academic collaborating with industry or working in industry – has positive effects, on both the intention to collaborate and patenting outcomes. This suggests the importance of creating opportunities for early career researchers to gain industry exposure and develop relevant skills and networks (Plantec et al., 2023, Wirsich et al., 2016).

These findings highlight the need for targeted support mechanisms that account for individual differences while addressing systemic barriers to participation in commercialisation activities. They also suggest the importance of developing programs that help individuals build the specific capabilities needed for successful cross-sector collaboration.

Key findings

- Studies demonstrate that previous experience – either as an academic collaborating with industry or working in industry – has positive effects on both intention to collaborate and patenting outcomes.
- Individual characteristics beyond academic position significantly influence commercialisation engagement, with prior experience, established networks and boundary-spanning capabilities being crucial success factors.
- Motivation for commercialisation extends well beyond financial incentives, varying by discipline and career stage, with societal impact, research enhancement and academic prestige being powerful drivers.
- Systemic gender barriers persist in UICs, reflected in approximately 10 per cent lower engagement rates for women-led research groups and compounded by career stage challenges and institutional structures.
- The development of individual boundary-spanning capabilities emerges as critical for successful commercialisation, requiring targeted support mechanisms throughout researcher careers.

2.3.6. Cross-Level Interactions and Relationships

The interaction between individual, team, organisational, and inter-organisational factors creates a complex ecosystem that shapes IP and commercialisation outcomes in UICs. Analysis reveals these levels do not operate in isolation but rather form an intricate web of dependencies and feedback loops that collectively determine success.

Individual-Organisational Interactions: Individual motivations and capabilities interact significantly with organisational structures and incentives to influence engagement in IP-generating activities. Research shows that even when individuals are motivated to pursue commercialisation, misaligned organisational incentive systems can create barriers (Marullo et al., 2021). For example, while academics may be driven by research enhancement and societal impact, traditional university promotion criteria that focuses solely on publications can discourage patent applications or industry engagement. Conversely, when organisations implement progressive reward systems that value commercial outcomes, this can amplify individual motivations and lead to increased engagement (Wang and Liu, 2022).

The effectiveness of boundary spanners – whether individual researchers or dedicated professionals – depends heavily on organisational support structures. Studies demonstrate that individuals with strong boundary-spanning capabilities can only effectively facilitate knowledge transfer when backed by appropriate organisational processes and resources (Olmos-Peñuela et al., 2016, Plata, 2024). This highlights how individual capacity for commercialisation is either enhanced or constrained by the organisational context.

Team-Organisational Dynamics: Team effectiveness in managing IP and commercialisation is significantly shaped by organisational culture and systems. Research shows that while teams may possess the necessary expertise combination, their ability to execute successful commercialisation often depends on organisational factors like clear IP policies, efficient decision-making processes, and adequate resource allocation (Tootell et al., 2020, Wirsich et al., 2016).

Furthermore, the success of intermediary teams like TTOs depends not just on team composition but on their positioning and authority within the organisation. Evidence suggests that when these teams are well-integrated into both academic and administrative structures, they can more effectively bridge the gap between research and commercialisation (Alexander et al., 2015, Son et al., 2019).

Inter-organisational-Individual Influences: The quality of inter-organisational relationships significantly impacts individual engagement patterns. Studies reveal that successful prior collaborations between organisations create pathways that make it easier for individual researchers to initiate new partnerships (Sheng and Hu, 2018, Wirsich et al., 2016). Conversely, when inter-organisational relationships

are strained by IP disputes or misaligned expectations, this can discourage individual researchers from pursuing commercial opportunities, regardless of their personal motivation (Schulse-Krogh and Calignano, 2019).

Cross-Level Trust Development: Trust emerges as a critical factor that operates across all levels simultaneously. Research demonstrates how trust building at the individual level through personal relationships supports team-level collaboration, which in turn strengthens inter-organisational partnerships (Ulhøi et al., 2012). However, this trust development process can be either facilitated or hindered by organisational policies and cultures. Studies show that when organisations prioritise quick wins over relationship building, this can undermine trust development at all levels (Tootell et al., 2020).

Resource Flow Dependencies: Resource availability and allocation create important dependencies across levels. Organisational decisions about resource allocation affect team capabilities, while individual success in securing external funding can influence organisational strategies. Research shows that this resource interdependency is particularly evident in IP management, where insufficient resources at any level can create bottlenecks in the commercialisation process (Perkmann et al., 2021, Hoppmann, 2021).

Gender Dynamics Across Levels: Gender-related challenges manifest across multiple levels in mutually reinforcing ways. Individual-level barriers faced by women researchers interact with team-level dynamics and organisational structures to create compound disadvantages. Studies show how these cross-level interactions can amplify gender disparities in commercialisation outcomes (Abramo and D'Angelo, 2021).

Key Findings:

- Success in IP management and commercialisation requires alignment across all levels.
- Misalignment at any level can create ripple effects that impact overall effectiveness.
- Trust development and resource flows operate as critical cross-level mechanisms.
- Individual capabilities must be supported by appropriate organisational structures.
- Sustainable commercialisation success depends on coordinated support across levels

3. Assumptions and Limitations of Findings

While this report provides comprehensive analysis, it is essential to acknowledge several key assumptions and limitations. The multi-level analytical framework, while valuable for understanding complex interactions, may not capture all nuances of IP management and commercialisation processes. Some important factors or relationships may exist outside this framework, though it provides a robust foundation for analysis. While the analysis draws from primary research studies, some relevant research published in languages other than English or in less accessible forums may have been overlooked, despite rigorous selection processes.

The rapidly evolving nature of IP management and commercialisation, particularly given technological advancements and changing global conditions, means some findings may become dated quickly. This is especially relevant for digital collaboration practices and emerging commercialisation models. Furthermore, while efforts were made to incorporate diverse perspectives, the literature remains focused on experiences from developed economies. This potential Western bias may limit the applicability of findings to different cultural and economic contexts.

Despite these limitations, this review provides valuable insights into current understanding of IP and commercialisation in UICs and offers a solid foundation for practical application and future research in this crucial area.

Table 3 Main themes relating to Intellectual Property and Commercialisation

Level of Analysis	Theme	Key Literature	Key Findings
Macro	Policy frameworks	Chapple et al. (2005), Wang and Liu (2022), Veletanlić and Sá (2019), Cohen et al. (2020), Ankrah et al. (2013), Son et al. (2019), Wirsich et al. (2016), Guerrero et al. (2021)	Policy frameworks significantly influence but do not determine commercialisation outcomes.
	Proximity related factors	Maietta (2015), O'Dwyer et al. (2022), Bojko et al. (2020), Tootell et al. (2020), Wirsich et al. (2016)	While geographic proximity remains relevant, cognitive proximity (shared knowledge and expertise) and social proximity (trust-based relationships) are equally or more important for successful UICs.
	Ecosystem dynamics	Chapple et al. (2005), Wang and Liu (2022), Veletanlić and Sá (2019)	Effective commercialisation requires coordinated support across the innovation ecosystem.
	Digital transformation	Xing et al. (2024), Wirsich et al. (2016), Hoppmann (2021), Song and Guan (2024), Plata (2024)	Digital transformation has enabled new forms of collaboration and knowledge exchange, but also brings challenges around virtual IP protection and cross-jurisdictional data ownership.
Organisational	Institutional structures	Wang and Liu (2022), Plantec et al. (2023), Kunttu and Neuvo (2019)	Institutional structures, policies, and culture play crucial roles in enabling or hindering successful IP management and commercialisation.
	Resource and support systems	Dalmarco et al. (2018), Fan et al. (2019), Guerrero et al. (2021)	Universities with comprehensive support systems that address legal, commercial, and administrative needs show enhanced IP management outcomes.
	Organisational culture	Jones and Coates (2020), Alexander et al. (2015)	Organisational culture, encompassing shared values, norms, and attitudes towards commercialisation can significantly impact researchers' incentives and behaviours.
Inter-organisational	Conflicting priorities	Wang and Liu (2022), Alexander et al. (2015), Sharifi et al. (2013), O'Dwyer et al. (2022)	Misalignment between academic and commercial priorities can complicate collaborations.
	IP management and open science	Bercovits and Feldman (2007), Perkmann et al. (2021)	Conflicting priorities regarding IP ownership, timelines, and open science create challenges.
	Triple Helix Collaboration	Bronneberg et al. (2023), Chai and Shih (2016), Oliver (2022), Cai and Amaral (2021)	Aligning the objectives of universities, industry, and government is crucial for creating a collaborative environment conducive to innovation.
Team	Composition and dynamics	O'Dwyer et al. (2022), Tootell et al. (2020), Wirsich et al. (2016)	Teams that effectively combine different perspectives demonstrate enhanced capability for managing the commercialisation process, but face challenges in reconciling different working styles and expectations.
	Leadership	Leišytė and Sigl (2018), Lee and Miosso (2014), Bronneberg et al. (2023)	Effective leaders facilitate industry relationships but often lack training in managing these complexities.
	External engagement and support	Wang and Liu (2022), Messeni Petrusselli and Murgia (2021), Kusior et al. (2024), Yoshioka-Kobayashi (2019)	External engagement teams, including TTOs, industry liaison officers, and dedicated project managers act as essential intermediaries. Departments and research institutes play a crucial role in enabling multidisciplinary collaboration and resource acquisition.
Individual	Motivations	Cohen et al. (2020), Abramo and D'Angelo (2021), Marullo et al. (2021), Perkmann et al. (2021), Oliver (2022), O'Dwyer et al. (2022), Olmos-Peñuela et al. (2016), Hoppmann (2021), Sheng and Hu (2018), Kusior et al. (2024)	Individual motivations for commercialisation extend beyond financial incentives, often emphasising career advancement, research enhancement, societal impact, and academic prestige.
	Boundary spanning	Chai and Shih (2016), Tootell et al. (2020)	Individuals with strong boundary-spanning capabilities, including communication skills, trust-building, and understanding of both academic and industry priorities are essential for successful collaborations.
	Gender and systemic barriers	Abramo and D'Angelo (2021), Maietta (2015), Bojko et al. (2020), Weerasinghe and Dedunu (2020), Wirsich et al. (2016)	Women academics face persistent structural challenges, including gender homophily and career stage challenges, which impact their access to resources and networks.
Cross-Level Interactions	Prior experience	Plantec et al. (2023), Wirsich et al. (2016)	Prior experience, either as an academic collaborating with industry or working in industry, has positive effects on both intention to collaborate and patenting outcomes.

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