HELIKON LABS

RESEARCH PAPER

Catalyzing Strategic Partnerships: Digital Transformation of University-Industry Collaborations for Synchronized Innovation

Andrew T. Flowers and Rebecca Roadman

Presented at the R&D Management Conference 2024, KTH Royal Institute of Technology, Stockholm, Sweden, June 17-19, 2024

About this version

This is the paper the authors presented at the R&D Management Conference 2024, reformatted by Helikon Labs. The figures and tables are redrawn from the same data, and the findings are unchanged.

The university-industry commercial technology pipeline (UI-CTP) framework introduced here is the foundation of the Helikon Method, the four-phase framework Helikon Labs works from today: Match, Unite, Steward, and Evaluate.

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1 Introduction

With ever increasing pressures on research and development organizations to improve commercialization outcomes while efficiently managing investments, industry and universities seek to increase the productivity of applied research collaboration projects between universities, industry supply chains, and government agency stakeholders within the ecosystems where they operate. Despite digital transformation efforts, challenges persist in identifying appropriate collaboration partners, navigating diverse stakeholder interests and engagement, aligning objectives, managing resource capacity and demand allocations, negotiating and monitoring fair and enforceable collaborative agreements, and maintaining regulatory compliance. Many digital tools are available on the market to assist in these functional areas, along with internally built applications, however, none meet all network needs to enable the mechanisms required of a collaborative ecosystem that efficiently transfers knowledge along the university-industry commercial technology pipeline (UI-CTP).

1.1 Research questions

- What are the key inefficiencies and challenges in the collaboration lifecycle of university-industry partnerships and how has digital transformation contributed to these frictions?
- How can collaborative digital ecosystems help address these frictions to improve technology commercialization and innovation outcomes?

2 Theoretical background

2.1 University technology transfer effectiveness

A review of the available technology transfer literature yields extensive efforts by many researchers to quantify and model the effectiveness of technology transfer activities by universities and government innovation organizations. Bozeman, Rimes and Youtie (2015) reviewed the advantages and disadvantages of existing effectiveness models using criteria of “Out-the-Door”, market impact, economic development, political, opportunity cost, scientific and technical human capital, or public value factors. In the general project management discipline, the Project Management Institute (2021) has established value drivers of business need, project justification, and business strategy as factors that any commercial project team need to consider in aligning the subjective nature of varying potential benefits from project outcomes to stakeholders’ interests. Although Out-the-Door and market impact success factors as criteria have limitations in measuring the total economic and social value capture of research from university perspectives, the measures are widely available and focus on microeconomics of the firms and projects where technologies are transferred, providing the most significance to business strategy, and therefore project satisfaction of industry partners. Quantifying the impacts of increased effectiveness of digital transformation on applied research collaboration success is beyond the scope of this study, however, others have found that efforts to increase project management maturity yield better project outcomes across a balanced scorecard of metrics, e.g. learning and growth, customer perspectives, and return on investment (Thomas and Mullaly 2006), with similar or decreased outlays in project control costs, e.g. management personnel, advisory, and information technology costs (Ibbs and Reginato 2002).

2.2 Strategic framework

Kotila, et al. (2023) performed a comprehensive assessment of United States defense innovation ecosystems to identify challenges and gaps in current technology development organizational structures and processes, developing a strategic framework of the "commercial technology pipeline (CTP)" – defined as the activities, functions, and processes by which the U.S. Department of Defense (DoD) identifies, develops, and adopts commercial technologies for military use. The defense innovation ecosystem analysis provides a useful starting point for developing a broader framework, as the CTP assessment concept is analogous to similar activities required by university-industry ecosystems for commercial technology development.

The field of strategic alliance management literature further provides useful context in mapping critical alliance management tools and activities that will contribute to success during the lifecycle of a university-industry technology development project.

Kale and Singh (2009) provide three simple lifecycle phases to consider the key success factors that drive any strategic alliance through formation and partner selection, alliance governance and design, and post-formation management. Clearly defining and aligning on the central objectives of the alliance during partner selection is critical because lack of alignment on objectives is a primary reason alliances fail. Differing perceptions should be openly discussed. When selecting a partner, university and industry participants should consider if their organization and culture is complementary, compatible, and committed to the alliance. Once partners are selected, and shared strategic objectives are articulated, performance should be regularly assessed against its strategic goals with a set of financial, strategic, operational, and relationship metrics using the balanced scorecard method. Agreeing upfront on specific circumstances and contingencies that will trigger alliance dissolution (e.g. missed milestones, cost overruns, achievement of objectives) and the process for winding down (e.g. communications, partner obligations) enables a smoother exit if the alliance needs to be terminated (Gulati, Sytch and Mehrotra 2008). This avoids relationship damaging haggling and inertia that can prolong a failing alliance and prevent future engagements.

Kale and Singh (2009) and Hoang and Rothaermel (2016) further provide an additional breakdown of alliance management tools that support these key success factors across alliance planning, formation, design, execution, evaluation, exit, and portfolio management.

In order to form a comprehensive strategic framework for analyzing the activities, management tools, and key success factors critical to enabling high value outcomes from university-industry technology collaborations, we adapted the CTP and strategic alliance frameworks to develop the university-industry commercial technology pipeline (UI-CTP) strategic framework, shown in **figure 1**, which we will utilize to map the use of digital tools across UI-CTP collaborations and analyze opportunities for reducing transaction costs and frictions through higher maturity digital transformation.

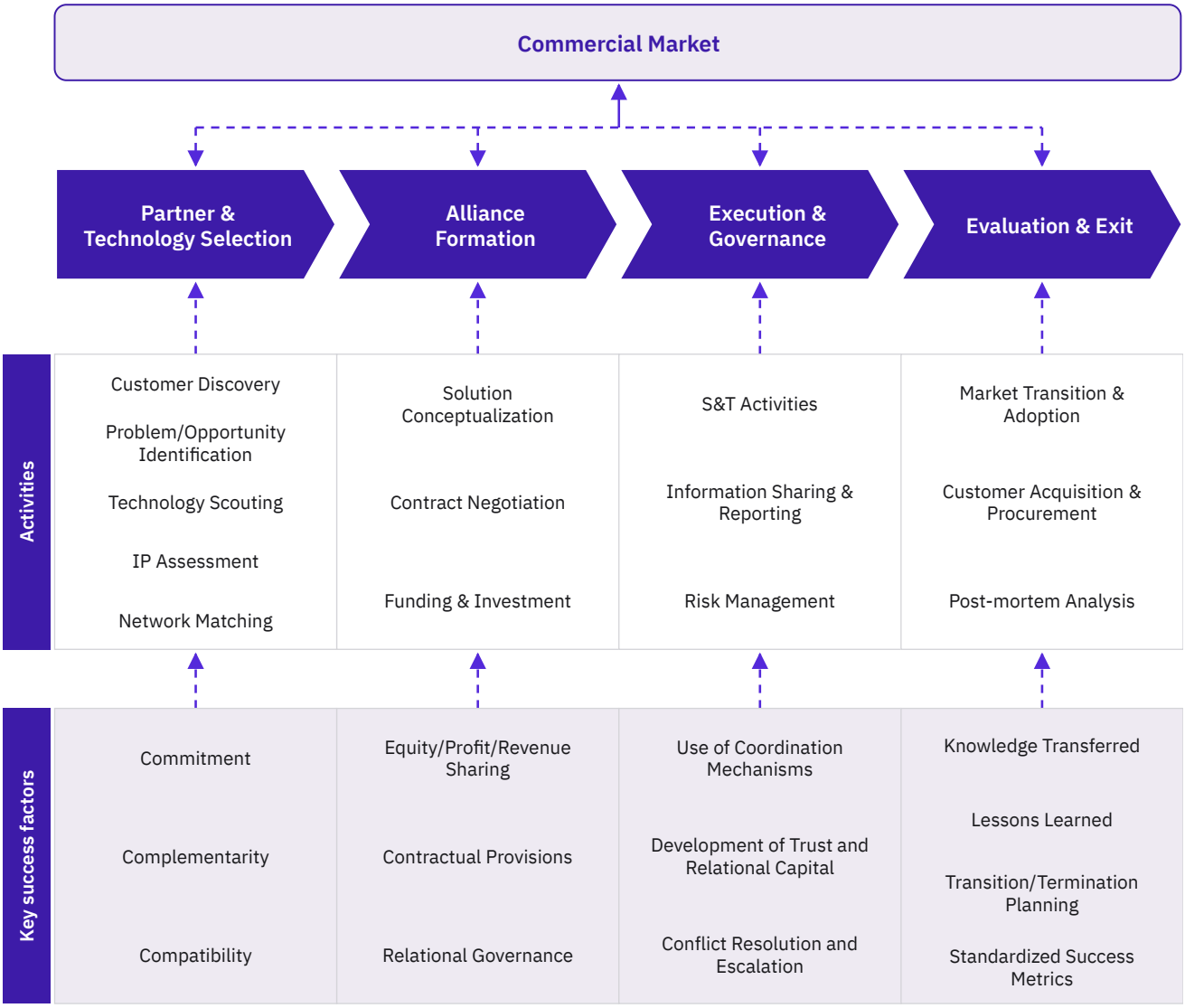


Figure 1. University-industry commercial technology pipeline (UI-CTP) strategic framework. Adapted from Kotila, et al. (2023), Kale and Singh (2009), and Hoang and Rothaermel (2016).

3 Research design

We adapted and redefined the CTP framework (Kotila, et al. 2023) and strategic alliance frameworks (Kale and Singh 2009) and (Hoang and Rothaermel 2016), to assess the digital collaboration processes between industry and universities for public and dual-use technology commercialization with fulfillment of commercial market needs as the driver of activity value. We conducted discussions in order to inform development of a survey of university and industry sponsored projects stakeholders to investigate the collaboration lifecycle functional processes at their organizations, the internal and external digital tools available to them, objectives and metrics measured to monitor performance, and their perceptions of effectiveness. We then assessed current leading software and SaaS types available on the market and performed a gap analysis compared to needs identified by existing analog and digital solutions against the adapted UI-CTP strategic framework.

3.1 Survey instrument, selection, and distribution

We employed connections to proximate university and industry experts to discuss and refine the scope of our inquiry. Utilizing insights from those conversations, we developed a set of survey questions designed to explore faculty perceptions of inefficiencies and challenges in the collaboration lifecycle of university-industry partnerships, and to understand their use of tools.

The survey was comprised of four core multiple choice or Likert scale questions with explanatory short answer prompts dependent upon respondents' selections. The survey also included 14 short answer questions. All questions were optional, and respondents did not necessarily answer every question.

Qualtrics software was used for the development and email distribution of the survey, which was disseminated to 218 assistant professors and chairs, followed by 583 associate, full, and named professors. Respondents spent a median 6.5 minutes completing the survey.

We selected five universities in the eastern and midwestern region of the United States—all major public research institutions with significant industry partnerships, high spending in research and development, and peers or affiliates of our home institutions. At those institutions, we chose fields with high propensity to partner, and some established partnership experience: biology, chemical engineering, chemistry, materials science, economics, and environmental science.

We selected assistant professors and department chairs initially for the purposes of study feasibility and control in departmental decision-making and governance, as well as conjecture about their vested interests based on career timeline. For assistant professors, we assumed particular attraction to partnership opportunities due to tenure-seeking research activities, and we reasoned that assistant professors might benefit from receipt of the survey as a secondary impact (i.e. prompting them to consider industry partnerships if they had not already). For chairs, we assumed broad knowledge of all faculty partnership activities within their department and field, as well as awareness of mounting budgetary pressures in higher education that might compel them to explore industry partnerships differently. In both cases, we failed to account for their heavy teaching and administrative workloads that might have inhibited the response rate (1 percent) at the time of year the survey was distributed, despite a moderate email open rate (59 percent) in the first distribution.

With few responses after multiple reminders to assistant professors and chairs, we expanded our distribution to associate, full, and named professors at the five selected universities, emphasizing biology, chemical engineering, chemistry, and materials science. Emeritus, courtesy, visiting, and teaching faculty at all levels were excluded. In the second distribution, response rates remained low (3 percent), but with a higher email open rate (69 percent).

Although Institutional Review Board approval was not required due to the nature of the study, we included recommended IRB language on confidentiality, data use, and consent in our emailed invitation. We incentivized participation by offering to share summary data with participants.

4 Data & Analysis

4.1 Surveys

Perspectives and experiences provided by responders were robust and informative. The number of responses remained far below that required for statistical significance, however, the purpose of the survey was exploration, not broad extrapolation. There was some representation from each surveyed institution, field, and role.

Moreover, the low response rate was informative per se. Although timing of the distribution potentially impacted response rate, we believe the lack of engagement may signal unfamiliarity with industry partnership opportunities, disidentification between their role and that of an industry partner, lack of awareness about broader higher education pressures and trends (including budgetary demands), and perhaps disinterest in contributing to solutions related to partnership challenges.

4.1.1 Identity of responders

Table 1 provides the number of respondents from each institution and their primary departments.

Table 1. Institution and department of survey respondents. Source: survey data.

Institution and Department	Count
U. Michigan, Ann Arbor	**1**
Materials Science & Engineering	1
U. Minnesota, Twin Cities	**4**
Biochemistry Molecular Biology and Biophysics	1
Biological Sciences	1
Chemical Engineering and Materials Science	1
Chemistry	1
U. North Carolina, The, Chapel Hill	**2**
Biology	2
U. Pittsburgh, Pittsburgh	**10**
Chem/Petroleum Engineering	3
Chemistry	1
Mechanical and Materials Science	6
U. Wisconsin-Madison	**3**
Chemical and Biological Engineering	1
Chemistry	2
Grand Total	**20**

Figure 2 shows the count of respondents categorized by their role within their institution. The highest response count came from full professors.

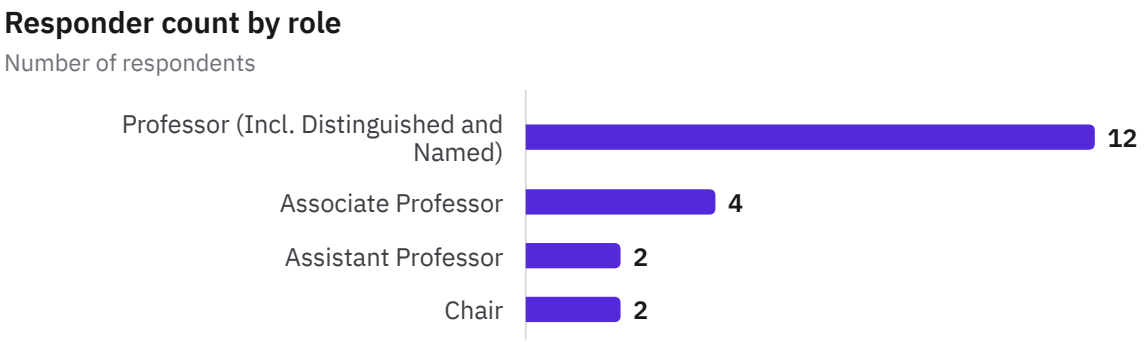


Figure 2. Responder roles with their institution. Source: survey data.

4.1.2 Nature of respondents' participation in industry partnerships

Most (80 percent) of our respondents participated in university-industry partnerships in the past, either as leaders or researchers. One respondent had facilitated partnerships from the university side, and one also had experience from the industry side. Of those that had participated in such partnerships, **figure 3** shows how they matched with their industry partners.

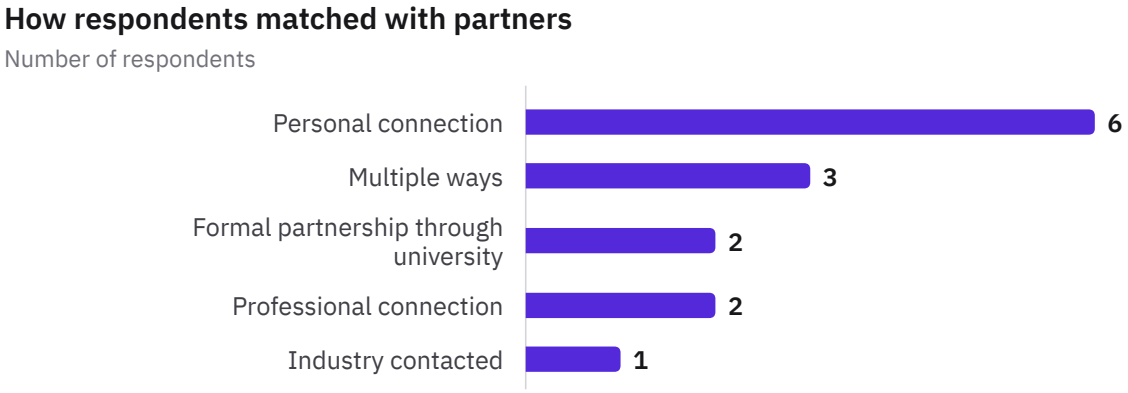


Figure 3. How respondents matched with industry partners. Source: survey data.

There was a range of experience represented in the survey results. The majority (8) of respondents participated in 1-to-5 partnerships, a few (4) participated in 6-to-10 partnerships, and a few (4) participated in over twenty partnerships. A few respondents (4) were unsure or provided no response. **Figure 4** categorizes the challenge themes that these respondents described experiencing within the industry collaboration project lifecycle. Intellectual property disputes and contract negotiation process breakdowns were the most common challenges.

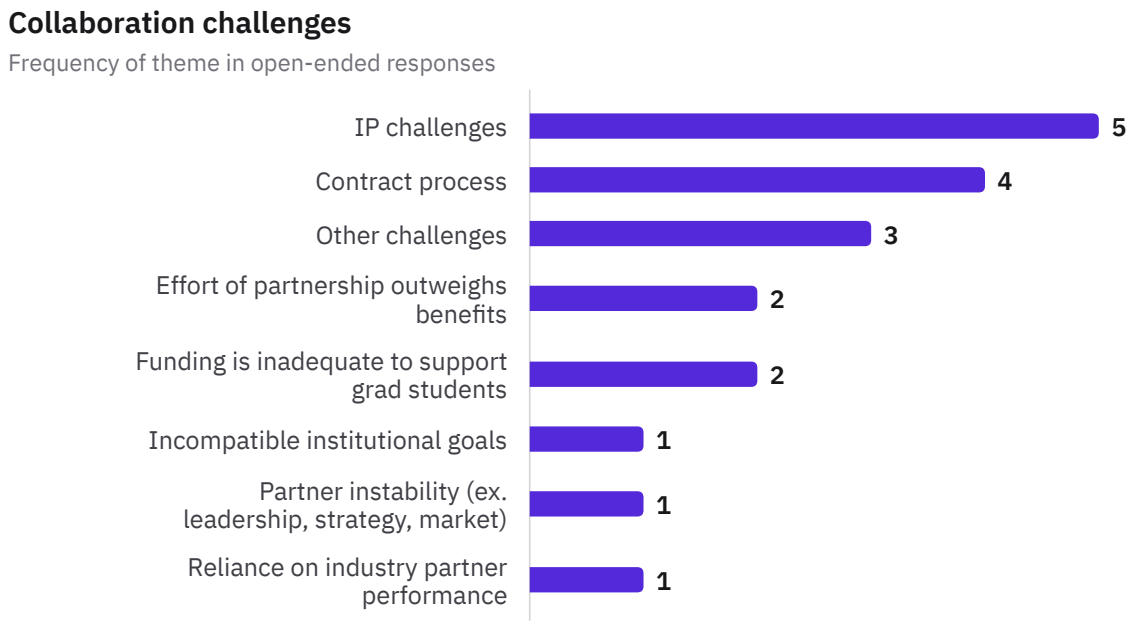


Figure 4. Collaboration challenges with industry research projects. Respondents cited one or more collaboration challenges. This chart shows the number of appearances of these distinct themes within the replies. Source: survey data.

We also asked university researchers how they define a successful collaboration with industry, **figure 5** categorizes the themes of their responses.



Figure 5. How respondents define successful collaboration with industry. Respondents cited one or more characteristics of successful collaborations. This chart shows the number of appearances of these distinct themes within the replies. Source: survey data.

4.1.3 Use of digital tools in partnerships

Respondents used a number of analog and digital tools to find partners, search patents and prior art for technology scouting, and perform market research of technology areas to pursue. **Figure 6** shows a word cloud of the various tools they reported using during these exploratory and discovery phases of the

industry partnership lifecycle.



Figure 6. Tools used in exploration and discovery phases of industry projects (e.g. to find partners, patents, or conduct market research). Source: survey data.

We also asked university researchers what tools they use to prepare and submit proposals to industry sponsors, how they negotiate with sponsors, and how they plan, manage, and report on the progress and results of their research projects. **Figure 7** shows a word cloud visualizing their responses. Of note, researchers are mostly not involved with the contract negotiation phase as institution-level legal and contract teams generally perform this function in a siloed manner.

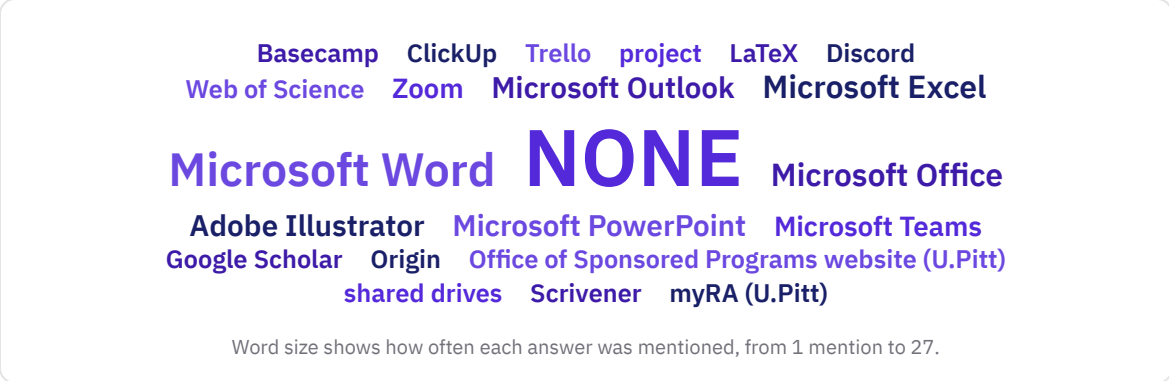


Figure 7. Tools used in proposal development, negotiation, and project management. Source: survey data.

4.1.4 Pulse on university-industry collaboration sentiment

A majority of responders, 85 percent, were “interested” or “very interested” in future partnership with industry. Those who were “neutral” (15 percent) cited reasons similar to the “collaboration challenges” they explained elsewhere, or they simply did not feel that partnership was relevant to them.

Among responders, 45 percent described their institution as “very supportive”, 40 percent “somewhat”, and 15 percent “neutral”. Responders’ reasons for interest in partnerships, and for describing their institution as “supportive”, aligned closely with the characteristics of successful collaborations and challenges that they defined previously. When processes were easy, effective, and clear, responders were eager to partner with industry.

A limited number of responders use artificial intelligence (AI) in industry sponsored research for proofreading, machine learning, or to solve technical problems for sponsors. However, most do not use generative AI and do not have intentions to, or feel unsure about future use.

4.2 Market assessment

We performed an assessment of the software market using company webpages and software market reports to identify the digital tools that can assist in managing the UI-CTP process. The software market is highly fragmented, but the tools available for completing activities required within the UI-CTP process can be segmented into the following categories:

- *Innovation Management Platforms*: Software systems that facilitate the innovation discovery process, from ideation, concept development, and technology and partner scouting. They provide a centralized hub for managing innovation discovery initiatives.
- *Customer Relationship Management (CRM)*: Software platforms that manage interactions with current and potential customers or partners. CRM platforms store customer data, track interactions, and automate various customer-facing processes.
- *Project & Portfolio Management (PPM)*: Software platforms used to manage execution and optimization of a portfolio of projects. PPM software helps with project planning, resource allocation, budgeting, scheduling, risk management, and performance tracking across individual projects or an organization's entire project portfolio.
- *Contract Lifecycle Management (CLM)*: Software platforms that automate the contract management process, from contract creation, redlining and negotiation, to execution of signatures, storage, and management of renewals and expirations. CLM tools help streamline contract workflows, ensure organizational policy and regulatory compliance, and minimize legal risks.
- *Knowledge Management Platforms*: Software systems designed to capture, store, retrieve, and share an organization's knowledge assets, such as documents, presentations, and spreadsheets.

These tools can collectively support the various processes involved in UI-CTP research partnerships, from initial opportunity discovery and identification, partner selection and negotiations, through to project execution, knowledge sharing, and post-alliance evaluation. **Figure 8** maps these digital tools to use-case activities within the UI-CTP process. **Table 2** provides further descriptions of the activities within each phase.

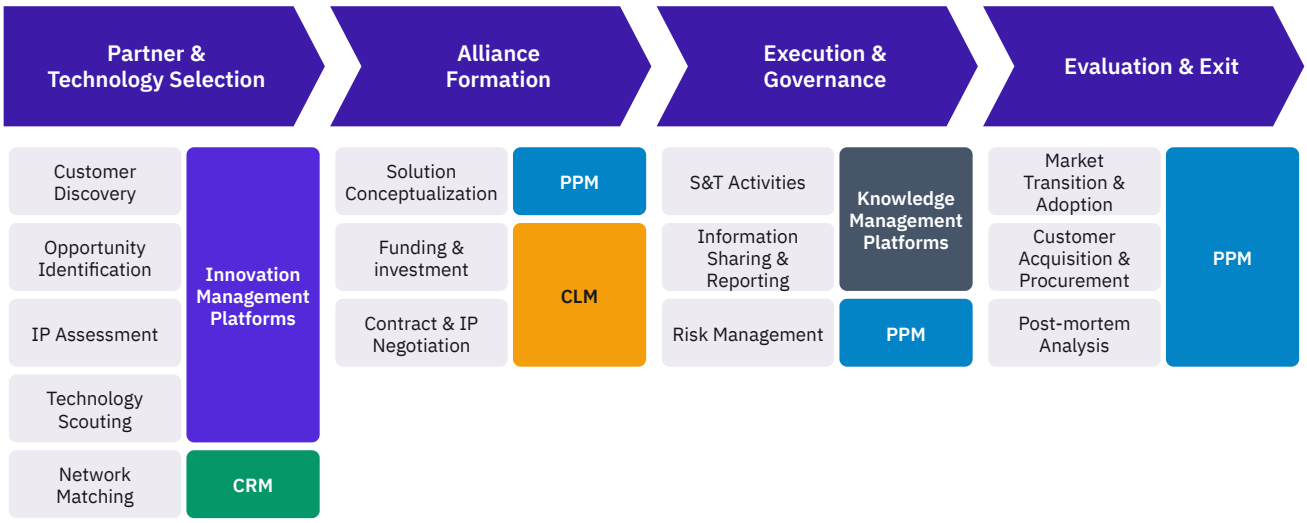


Figure 8. Digital tools available from commercial software market mapped to activities within the UI-CTP process.

Table 2. Descriptions of UI-CTP process activities mapped to digital tools available for management.

UI-CTP process activity	Description	Tool
Customer discovery	Identifying end-use commercial market participants that have unmet technological needs	
Opportunity identification	Identifying high value commercial problems that have unmet needs for technological solutions and developing a business case	**Innovation management platforms**
IP assessment	Searching for prior-art and landscaping existing inventions for commercial opportunities	
Technology scouting	Identifying technology fields of research that require development to achieve commercial readiness	
Network matching	Identifying and matching with research partners to perform collaborative technology development activities	**Customer relationship management (CRM)**
Solution conceptualization	Creating initial development concepts and preparing a statement of work for a defined business case and project	**Project & portfolio management (PPM)**
Funding & investment	Budgeting and negotiating development costs for a defined project. Identifying funding sources	
Contract & IP negotiation	Conducting due diligence of partners, negotiating collaboration goals, regulatory compliance requirements, liability and intellectual property ownership or option licensing	**Contract lifecycle management (CLM)**
S&T activities	Management of scientific activities, budget and timeline compliance to meet development goals	
Information sharing & reporting	Sharing of technical information generated through the course of a development project	**Knowledge management platforms**
Risk management	Identification, communication, and mitigation of any potential obstacles to meeting project goals	
Market transition & adoption	Transfer of applied research knowledge generated for technology scale-up, qualification, or demonstration in the commercial market, feedback from commercial customers for continued or further unmet development needs	**Project & portfolio management (PPM)**
Customer acquisition & procurement	Feedback loops from commercial market entry of technology success or failure. Tracking of revenue, volume, profits, quality concerns, etc.	
Post-mortem analysis	Measurement and reporting of balanced scorecard project outcome metrics. Evaluation of collaboration relationship and decisions to fix, expand, or terminate future engagements.	

5 Discussion

The results of our discussions with and surveys of university and industry collaborators indicate that some processes are unclear and confusing across disparate siloed functional groups with varying objectives, particularly contract and IP negotiating teams, using digital tools that are fragmented and underperforming against the potential of their purposes. Internal and external processes are adapted

around the proliferation of common digital tools, such as desktop applications and email that are easily accessible to them for functional activities, rather than strategically designed to optimize the collaborative innovation process synergistically.

5.1 Digital collaboration tools gap analysis

A gap analysis of the digital tools used by researchers responding to our survey versus available software tools on the market mapped to our UI-CTP strategic framework reveals that the tools currently utilized are insufficient in satisfying all needs of a university-industry commercial technology pipeline. Investment is needed in shared, digital collaboration platforms that can enable the mechanisms for information coordination and feedback loops that are missing from the existing interactions driven primarily by personal expertise and connections rather than organizationally aligned priorities and objectives. Ecosystem intermediaries could play a beneficial role in creating digital platforms that can cross organizational boundaries while maintaining trust and security requirements.

6 Practical implications, limitations, and future research

The scale of opportunity costs for universities that cannot effectively collaborate with industry on basic and applied research, and experimental development projects is staggering. The business sector funded over 75 percent of U.S. R&D in 2021, (the last year data was available), but less than one percent of this funding was performed by universities, representing approximately six percent of the total research performed by universities (National Science Board 2024). Clearly, there is much room for university-industry research partnerships to grow, and driving shared digital and collaboration process transformation to reduce frictions and achieve better innovation project outcomes can be a part of university and industry efforts to increase value capture.

Digital tools cannot counterbalance the lack of good processes and skilled administrators in key enabling functional areas, such as proposal and contract management, intellectual property management, and accounting and budgeting management, however, well implemented software solutions can help to create clearer, faster, and higher maturity processes resulting in better project outcomes.

Future research is needed to understand sentiment and challenges to expanding university-industry collaborations in other fields that were beyond the scope of this study, particularly with the recent expansion of research and development in artificial intelligence technologies, such as in computer science, linguistics, psychology, and health sciences. We also plan further work to include responses from a broader set of higher education research institutions from other geographies and scopes of research expenditures to gain more comprehensive insights. Insights from university researchers regarding the special challenges of collaborating with small and medium businesses also warrants further work to uncover their unique circumstances from industry partner perspectives.

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About Helikon Labs

Helikon Labs provides strategic consulting and technology for research and development. For the researchers, companies, tech transfer offices, students, and investors who take part in cross-organizational research collaborations, the company develops solutions for the friction and misalignment that cause these partnerships to underperform. Founded in 2024, Helikon Labs combines original primary research on innovation management, a four-phase partnership framework (the Helikon Method), and an R&D collaboration platform that matches research partners by their expertise and manages the partnership lifecycle in one place. Its consulting practice and a tools and assessments store complement the platform.

Learn more at helikonlabs.com.

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