

Innovative impact indicators for university-industry collaboration

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Abstract

University-Industry Collaboration (UIC) is increasingly vital for innovation, yet its success is often measured by narrow, traditional metrics like patent counts and licensing income. This approach fails to capture the full spectrum of value generated, including process efficiencies, human capital development, and broader societal benefits. This paper addresses this gap by proposing a holistic, multi-dimensional framework of innovative impact indicators. Synthesizing key findings from systematic literature reviews, the paper structures indicators into three critical domains: Input Indicators that measure the potential for success, Process Indicators that assess the health and management of collaboration, and Output and Impact Indicators that evaluate the full range of economic, institutional, and socio-environmental outcomes. The framework is grounded in the practical need for better measurement tools, as highlighted by feedback from international funding programs. It offers a practical and robust tool for universities, industry partners, and policymakers to more accurately evaluate and enhance the true value of their collaborative ventures.

Keywords: university-industry collaboration; impact indicators; innovation management.

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1. INTRODUCTION

University-Industry Collaboration (UIC) is widely recognized as a cornerstone of modern innovation ecosystems, serving as a critical engine for economic growth and technological advancement (Ankrah and Al-Tabbaa, 2015; Rybnicek and Königsgruber, 2019). Policymakers, academic leaders, and corporate executives increasingly look to these partnerships to solve complex societal challenges and maintain a competitive edge in a globalized, knowledge-based economy (Borges et al., 2022). Despite their strategic importance, evaluating the success of these collaborations remains a significant challenge. The methods generally used may not keep pace with the evolving complexity of these relationships, creating a critical measurement gap.

In the past, assessments of university–industry collaborations (UIC) have often focused on a limited range of outcomes that are straightforward to measure and largely centered on economic gains. Typical ways to measure collaboration include looking at how many patents are created, how much money comes from licensing deals, or how many research papers are published together (Perkmann et al., 2013). While valuable, these metrics provide an incomplete and often misleading picture of a partnership’s true value. This narrow view fails to account for three critical dimensions of success. First, it neglects the foundational “input factors”—such as institutional stability and human capital—that are the essential predictors of successful outcomes (Ćudić et al., 2022). Second, it overlooks the quality of the collaborative process itself, including the relational dynamics of trust, communication, and strategic alignment that are vital for translating potential into results (Rybnicek and Königsgruber, 2019). Finally, and perhaps most importantly, such assessments fail to capture the broader and often intangible social and environmental impacts, including contributions to public health, the development of sustainable technologies, and the creation of human capital (Ervits, 2024).

This measurement gap creates a critical problem: it leads to an undervaluation of partnerships whose primary benefits are institutional or societal, and it provides managers and policymakers with limited actionable insights for improving collaboration design.

The specific objective of this paper is to address this gap by proposing a holistic and multi-dimensional framework of innovative impact indicators for UIC. This framework is developed by synthesizing the findings from a comprehensive review of key academic literature to construct a model that is both theoretically robust and practically applicable, enabling stakeholders to more accurately assess, manage, and articulate the full value of their collaborative efforts.

2. THEORETICAL FRAMEWORK

The evaluation of UIC is a complex, multi-faceted challenge that has evolved significantly in academic literature. A robust theoretical framework for developing innovative impact indicators must therefore synthesize several distinct but complementary streams of research. This review consolidates four primary perspectives that collectively form the foundation for the holistic model proposed in this paper: the Input-Output model, the Process and Success Factor model, the Socio-Environmental Impact model, and the overarching Bibliometric Landscape.

The most foundational approach to understanding UIC performance is the Input-Output model. This perspective treats collaboration as a system in which specific enabling conditions directly influence measurable results. Ćudić et al. (2022) proposed a model, validated through statistical analysis, demonstrating that investments in specific input areas are key to achieving successful outcomes in university–industry collaborations. They highlight four main types of inputs. Institutional factors include organizational and national support, such as R&D spending and a stable political environment. Human factors refer to the availability of skilled researchers who can actively contribute to projects. Linkage factors capture the intensity of interactions between universities and industry, such as joint funding arrangements and collaborative research initiatives. Finally, framework factors involve the underlying infrastructure, including digital and information technology systems, that facilitate effective cooperation. Together, these inputs help explain why some collaborations produce stronger results than others. These inputs, in turn, produce tangible outputs like new products and intangible outputs



such as patents and new business models. This model establishes a critical baseline: to understand impact, one must first measure the foundational resources and conditions that make it possible.

Nevertheless, the link between inputs and outputs is not automatic; it is mediated by the quality of the partnership itself. This brings us to the Process and Success Factor model, which focuses on the relational and managerial dynamics *within* the collaboration. After reviewing over a hundred studies, Rybnicek and Königsgruber (2019) emphasize that the strength of partnerships is a key driver of successful university–industry collaborations. Factors such as trust, clear communication, and shared commitment form the foundation of these strong relationships. Their analysis brings together a wide range of research into a detailed model of success, highlighting how the quality of interactions between partners can determine the effectiveness of collaborative efforts.

As Barnes et al. (2002) found in their classic case studies, effective interaction is the bedrock of successful R&D projects. Furthermore, Rybnicek and Königsgruber (2019) highlight the importance of institutional factors like flexibility and clear governance, and output factors like the clarity and alignment of objectives. This perspective is reinforced by Ankrah and Al-Tabbaa (2015), whose review concludes that most successful UICs are treated as a “*rational process*” (p.396), requiring deliberate management, clear roles, and strong governance to navigate the inherent barriers, such as the cultural divides and bureaucratic hurdles identified by Muscio and Vallanti (2014). While

the first two models explain *what* is needed and *how* it should be managed, the third perspective addresses the crucial question of *what constitutes true impact*.

The Socio–Environmental Impact model argues for expanding the definition of success beyond purely economic metrics. The research by Ervits (2024) is central to this view, demonstrating that the most impactful collaborations are often “*communities of shared values*” (Ervits, 2024, p.2) that aim to solve societal problems. This perspective shifts the focus to outcomes that benefit the public good, proposing four core categories of social benefits: improvements in health and quality of life, the creation of environmental solutions, knowledge creation for social good, and human capital development through training and job creation. This aligns with the broader push to evaluate university “third mission” activities (Molas-Gallart et al., 2002) and recognizes that the development of human capital is one of the most unique and valuable outputs of the UICs (Schofield, 2013).

Finally, the Bibliometric Landscape provides a meta-analysis that validates the centrality of these themes. The review by Borges et al. (2022) maps the entire research field, confirming that Innovation, Cooperation, and Knowledge Transfer are the most dominant concepts in the literature. Their analysis also reveals an evolving focus on contemporary outcomes like “*Academic Entrepreneurship*” (p.12) and “*Commercialization*,” (p.12), reinforcing the need for forward-looking indicators. This broad view confirms that a comprehensive framework must account for the foundational inputs, the relational process, and a

multi-dimensional definition of impact that includes economic, institutional, and societal outcomes. While each of these theoretical streams offers valuable insights, they have often been explored in isolation. The primary contribution of the framework proposed in this paper is to synthesize these distinct perspectives into a single, integrated, and practical tool for the holistic evaluation of UIC.

3. CONTEXT OF THE DESCRIBED RESEARCH

The development of this framework is driven by a dual context: on one hand, the fragmented state of academic research on UIC measurement and, on the other hand, a clear and pressing demand from the field for more effective evaluation tools. It is not merely an academic exercise but a direct response to this evident need for practical and robust approaches.

The academic landscape has produced several invaluable systematic reviews that map the field. For instance, the work of Ankrah and Al-Tabbaa (2015) provides a comprehensive end-to-end process model, breaking down UIC into five core themes: motivations, forms, formation, facilitators/barriers, and outcomes. Similarly, the review by Rybnicek and Königsgruber (2019) extracts the critical success factors that determine the health of the partnership itself, emphasizing relational dynamics like trust, communication, and mutual commitment. Other research has focused on specific aspects, such as the motivations for academic engagement (Perkmann et al., 2013), the common barriers and obstacles to success (Muscio and Vallanti, 2014), or the unique social and environmental benefits that collaborations can generate (Ervits, 2024).

While each of these research streams provides deep insights, their specialization has resulted in a patchwork of disparate models and concepts. For a university manager, industry partner, or policymaker seeking guidance, there is no single, unified framework that connects the foundational inputs (Čudić et al., 2022) with the collaborative process (Rybnicek and Königsgruber, 2019) and the full spectrum of

multi-dimensional outcomes (Ankrah and Al-Tabbaa, 2015; Ervits, 2024). This fragmentation leaves practitioners with a theoretical toolbox of individual parts but no clear instructions on how to assemble them into a functioning engine for evaluation.

This academic context is mirrored by a pressing practical demand. The need for an integrated framework was starkly illustrated by the feedback received on a recent Erasmus+ Capacity Building project proposal. The project, designed by a consortium of European and Latin American partners to enhance student employability through an Internet Work-Based Learning (IWBL) model, was praised for its high relevance. However, the evaluators identified a critical, overarching weakness. Their feedback stated that the proposal “*lacks a robust framework for measuring impact*” and “*does not present an appropriate set of indicators or baseline data.*” This real-world example is not an isolated case; it is representative of a broader shift in expectations from funding bodies and stakeholders. There is a clear demand to move beyond narratives of activity and simple output counts toward a sophisticated, evidence-based demonstration of value.

Therefore, the framework presented in this paper was developed to bridge this critical gap. It directly responds to the practical need for better measurement tools by synthesizing the fragmented academic knowledge into a single, coherent, and actionable model. Its context is one of translation: transforming the rich but disjointed insights from the literature into a practical solution for the field.

4. MAIN RESULTS

The primary result of this research is a comprehensive, three-part framework of innovative indicators designed to provide a holistic and evidence-based assessment of UIC. This framework synthesizes the different streams of academic literature into a single, practical tool. It is structured to evaluate a collaboration across its entire lifecycle: the foundational conditions that enable it, the health of the collaborative process itself, and the full spectrum of its multi-dimensional impact.

Part 1: Input indicators (the foundation for success)

The success of any collaboration is fundamentally dependent on the quality of its foundational elements. Merely initiating a partnership is no guarantee of a valuable outcome; the right enabling conditions must be in place. This section outlines the critical input indicators, adapted from the statistically validated model of Ćudić et al. (2022), which measure the potential for success.

Institutional factors: Indicators like these offer a baseline understanding of the conditions necessary for successful partnerships. These indicators give a sense of how supportive a country's economic and policy environment is for research and innovation. Among them, the Gross Expenditure on R&D (GERD) stands out as a particularly useful measure, showing the level of resources a country dedicates to developing its research capabilities. At the organizational level, this translates into the clarity and consistency of university policies regarding Intellectual Property (IP), overhead, and contracting. As Muscio and Vallanti (2014) have shown, bureaucratic and administrative hurdles are among the most significant perceived obstacles to successful collaboration. Therefore, measuring process efficiency, such as the time taken to approve a research contract or a Non-Disclosure Agreement (NDA), serves as a practical indicator of a supportive institutional environment. The presence of dedicated support structures, like a well-resourced Technology Transfer Office (TTO), is another critical measure of an institution's readiness for effective engagement (Ankrah and Al-Tabbaa, 2015).

Human factors: This category focuses on the quantity and, more importantly, the quality of the available human capital. The most significant indicator identified by Ćudić et al. (2022) is the density of Researchers in R&D. For a specific collaboration, this can be measured by the number of PhDs and postdocs involved in industry-funded projects. Furthermore, the quality of these researchers is paramount. An innovative indicator is the percentage of faculty with prior industry experience, as this suggests a greater understanding of commercial contexts and timelines. Equally important is the involvement of the next generation of talent,

measured by the number of student internships and co-supervised theses, which serves as a leading indicator of future knowledge transfer and talent pipeline development (Ankrah and Al-Tabbaa, 2015).

Linkage factors: These indicators measure the intensity and nature of the direct interaction between the university and industry partners. The strongest predictors of success, according to Ćudić et al. (2022), are GERD performed and financed by a business enterprise. At the project level, this translates into the percentage of R&D budget provided by industry sources, including the estimated value of in-kind contributions such as equipment, materials, or staff time. The number of active projects and the volume of joint publications serve as straightforward measures of the intensity of collaboration. A more nuanced indicator is personnel exchange, measured in person-days, where staff move between organizations, as this facilitates the transfer of tacit knowledge, which is often more valuable than formal deliverables (Schofield, 2013).

Part 2: Process and success factor indicators (the health of the partnership)

Strong inputs are necessary but not sufficient for success. The bridge between potential and impact is the collaborative process itself. This section outlines indicators derived from the extensive systematic review of Rybnicek and Königsgruber (2019), which measure the health, quality, and management of the partnership.

Relationship quality: This is arguably the most critical set of process factors, focusing on the interpersonal and inter-organizational dynamics. Effective communication plays a crucial role in successful collaboration. It can be tracked in simple ways, such as the frequency with which partners hold formal or informal meetings to stay in touch. Instead of only tracking the number of meetings, a better way to see if communication works is to check whether partners begin using a common language, indicating they have overcome the differences between academic and industry terminology. Mutual trust is another universally cited success factor (Ankrah and Al-Tabbaa, 2015). It can be measured by the track record of partners delivering on their promises and, qualitatively, by the perceived

openness in discussing challenges and failures. Finally, mutual commitment is a leading indicator of a partnership's longevity and can be measured by the level of visible support from senior leadership and a demonstrated willingness to plan for future collaborations beyond the current project's scope.

Management and governance: A healthy relationship must be supported by effective management structures. The presence of a 'collaboration champion'—a key individual who drives the partnership forward—is a well-documented facilitator (Ankrah and Al-Tabbaa, 2015). The effectiveness of governance can be measured by the existence of a joint steering committee and the clarity of a shared strategy document that outlines roles, responsibilities, and milestones. The degree of cultural compatibility between the open, long-term orientation of academia and the proprietary, short-term focus of industry is a critical success factor that, while challenging to quantify, can be assessed through periodic partner surveys.

Framework and legal alignment: This concerns the formal structures that govern the collaboration. A key indicator is IPR policy flexibility, measuring the university's ability to adapt its standard procedures to meet the needs of an industry partner. The clarity of legal contracts—defining deliverables, confidentiality, and ownership—is essential for preventing the kinds of disputes that frequently derail collaborations (Muscio and Vallanti, 2014). Furthermore, the partnership's ability to operate within the broader external environment can be measured by its success in leveraging public funding or tax incentives.

Part 3: Output and impact indicators (the full spectrum of results)

This is the state-of-the-art component of the framework, moving beyond a single definition of success to capture the multi-dimensional value created. As illustrated in Figure 1, impact is divided into three distinct but interconnected domains: Economic and Innovation, Institutional, and Social and Environmental.

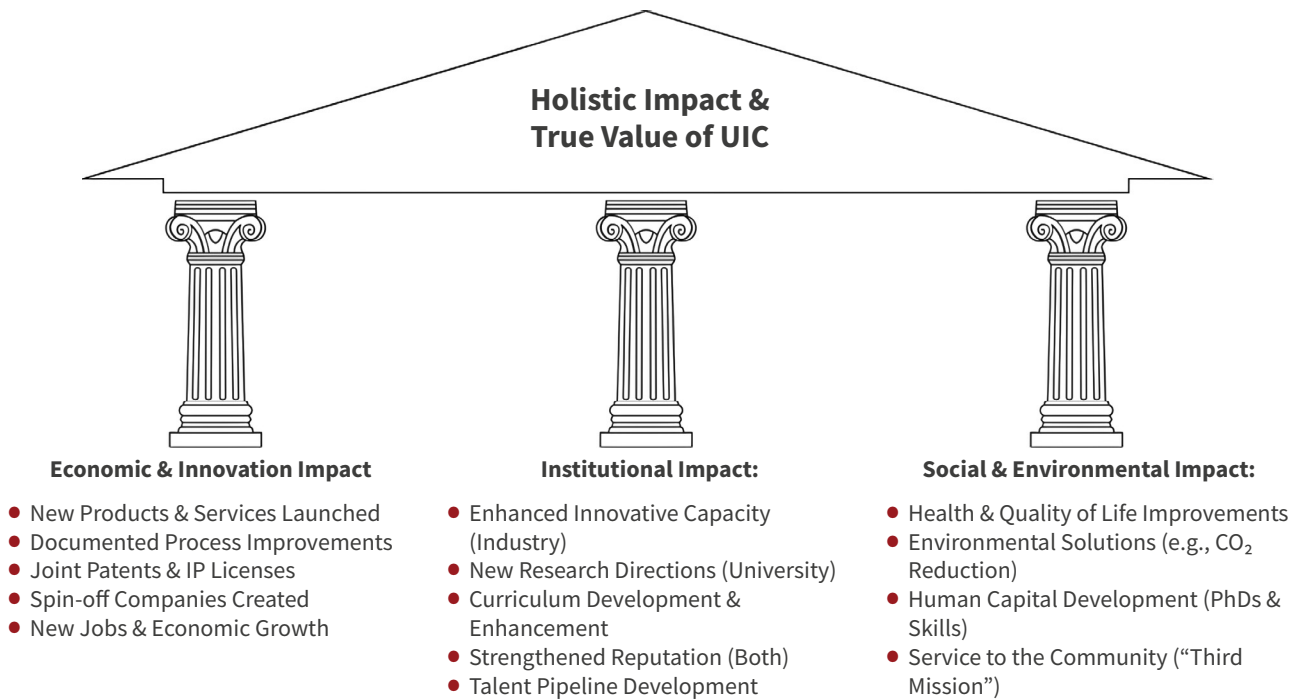
The specific indicators within these domains are as follows:

Economic and innovation impact: These are the direct commercial and technological outputs, often considered the traditional markers of success. Key indicators include the number of joint patents filed and granted, and the number of new products or services launched based on the collaboration's research. Beyond simple creation, impact can be measured by documented process improvements implemented by the industry partner (e.g., a 15% reduction in manufacturing costs). The entrepreneurial impact, a theme of growing importance (Borges et al., 2022), is measured by the number of spin-off companies created and the amount of follow-on funding secured. Finally, direct economic contribution is measured by new jobs created and the revenue generated from licensing the IP.

Institutional impact: These indicators measure the often-overlooked benefits to the partners' internal capabilities and knowledge base. For universities, a key impact is the development of new or updated curricula informed by real-world problems, and the generation of new research directions that would not have emerged without industry insight. For the industry, a critical indicator is enhanced innovative capacity, reflecting the absorption of new knowledge and skills, and the accelerated commercialization of technologies (Ankrah and Al-Tabbaa, 2015). For both partners, an important but intangible outcome is an enhanced reputation within their respective fields.

Social and environmental impact: This dimension captures the contribution to the public good, drawing heavily on the framework proposed by Ervits (2024). These indicators measure a collaboration's success in acting as a "community of shared values" (p.2). Indicators for Health and Quality of Life include the number of new medical treatments or diagnostic tools advanced into clinical trials. Environmental Impact is measured by quantifiable outcomes such as the reduction in CO2 emissions or the development of cleaner manufacturing processes. Finally, Human Capital Development represents a unique societal contribution of UICs and is measured by the number of Master's and PhD degrees facilitated for students and employees, and the number of post-doctoral researchers trained with skills relevant to both academia and industry.

Figure 1. A multi-dimensional framework of UIC impact



Note: Adapted from Ankrah and Al-Tabbaa (2015), Ervits (2024), and Ćudić et al. (2022).

The primary strength and innovation of this three-part framework is its integrated and diagnostic nature. It moves beyond a simple, static checklist of outputs to provide a dynamic tool for management and evaluation. By simultaneously measuring the foundational inputs, the health of the collaborative process, and a multi-dimensional set of impacts, stakeholders can develop a nuanced understanding of a partnership’s performance. This framework allows for a shift from asking “Was this collaboration successful?” to asking the more insightful question, “Why was this collaboration successful (or not), and how can we improve?” It provides a structured methodology to identify the root causes of success or failure, offering clear, actionable insights for university leaders, industry managers, and policymakers aiming to foster more effective and truly impactful collaborations.

5. CONCLUSION

This paper set out to address a critical and persistent gap in the evaluation of UICs. While the strategic

importance of these partnerships is undisputed, the frameworks used to measure their success have remained narrowly focused on traditional, economic-centric metrics, providing an incomplete and often misleading picture of their true value. By synthesizing a wide body of systematic literature, this research has constructed a holistic, multi-dimensional framework of innovative impact indicators designed to bridge this measurement gap.

The primary result of this work is the proposed three-part framework, which provides a comprehensive lens for assessment. It begins by establishing the Input Indicators—the foundational institutional, human, and linkage factors that create the potential for success, as validated by the work of Ćudić et al. (2022). It then moves to evaluate the Process and Success Factor Indicators, which assess the health and management of the partnership itself, focusing on the critical relational dynamics of trust, communication, and governance identified by Rybnicek and Königsgruber (2019). Finally, and most innovatively, the framework redefines success through its multi-dimensional Output and

Impact Indicators. This final component moves beyond a singular focus on economic returns to provide a balanced view that includes Institutional Impact—such as enhanced innovative capacity and curriculum development—and the vital Social and Environmental Impact, including contributions to public health and human capital development, as highlighted by Ervits (2024) and Ankrah and Al-Tabbaa (2015).

The central contribution of this paper is not the invention of new metrics from scratch, but the synthesis of fragmented academic knowledge into a single, coherent, and practical tool. It transforms a collection of disaggregated concepts into an integrated ‘balanced scorecard’ that stakeholders can actively use. The implications of this are significant. For university and industry managers, the framework serves as a diagnostic tool, enabling them to identify weaknesses not just in the outcomes, but in the foundational inputs or the collaborative process itself. This provides actionable insights for designing and managing more effective partnerships. For policymakers and funding agencies, it offers a more sophisticated and defensible methodology for evaluating proposals and assessing the return on public investment. It allows them to justify support for collaborations based on a broader and more accurate definition of value, including long-term institutional and societal returns.

While this framework provides a robust model, it is not without limitations. As a conceptual model derived from a literature synthesis, its primary limitation is that it has not yet been empirically validated on a large scale in this integrated form. The relative weighting and importance of each indicator will likely vary depending on the specific context, such as the industry sector, the national innovation system, or the maturity of the collaboration.

These limitations, however, illuminate clear directions for future research. The most critical next step is the empirical validation of the proposed framework through case studies and large-scale surveys across diverse UICs. Longitudinal studies are also needed to understand how the relevance of these indicators evolves over the different phases of a partnership’s lifecycle. Finally, further research could focus on adapting and tailoring the framework for specific contexts,

such as collaborations in the social sciences and humanities, where impact is often even less tangible.

In summary, by moving beyond traditional metrics and embracing a more holistic perspective, this framework offers a path toward a more meaningful and accurate valuation of UIC. By measuring what truly matters, we can better understand, manage, and ultimately enhance the capacity of these vital partnerships to generate lasting value for both the organizations involved and for society as a whole.

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