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# Measuring the societal impacts of university-industry R&D collaborations

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**Abstract**

Given the growing interest in understanding the social dimension of R&D investments better, approaches for measuring the societal impact of university-industry R&D collaborations (UICs) are called for. Several studies claim that such collaboration directly impacts innovation and, consequently, economic growth. In recent years, several papers have sought to assess the impacts of these collaborations. However, the interest seems to be focused on two of its main stakeholders: companies and universities. Few studies integrate university, industry and society outlooks on societal impact. Based on systematic literature review, this paper aims to provide a conceptual framework for the key elements that should be considered when measuring the societal impact of UICs, contributing to a theoretical understanding of the subject.


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## 1. Introduction

Companies demand universities skills and knowledge to stimulate innovation and be more competitive, creating economic, financial, and social impact [1]. Such social impact is multidimensional by nature, because it affects individuals, communities, and society at large [2], and it encompasses broader - cultural, health, welfare, environmental, and economic - dimensions, among others [3]. Along these lines, the social impact of inter-organizational relationships is fundamental to their financial performance, since such performance is affected by how institutions address sustainability, represented in environmental, social and governance (ESG) scores that reflect the level of corporate social responsibility [2,4]. When the university system cooperates with industry in funded research projects, the company, the university, and society at large expect to see the effects thereof [5].

At the social level, the literature recognizes that scientific, industrial, and regional communities are impacted by university-industry R&D collaborations (UICs) through knowledge creation and exchange [6]. However, measuring these impacts is a complex task due to the heterogeneity of the institutions involved in the collaboration, the diversity of interests and objectives of each stakeholder, the need to identify different indicators at each stage of the collaboration, and the nature of the activity to be developed [5]. There is evidence that in recent years publications focusing on measuring the impact of UICs have increased in number. One reason for this trend may be the growing demand from funding institutions to know the real contribution of investments in research [7]. There is also a need to oversee and manage the performance of higher education institutions and allocate future funding [8].

The field of study of UICs is quite diverse. However, the literature recognizes a gap at the institutional level in research into social and economic impact of UICs, the effects of knowledge transfer to society, and how changes in the institutional environment impact the engagement of academics in R&D projects [9]. This study aims to provide a framework, based on systematic literature review, to guide the measurement of the societal impact of UICs and facilitate their theoretical understanding.

The paper is structured as follows. First, it analyzes the need for and challenges of measuring the societal impacts of UICs. Second, it explains the research methodology applied. Third, it describes the proposed framework for UIC impact measurement based on systematic literature review. Finally, conclusions and limitations are presented.

## 2. Background

### *2.1. Measuring the societal impact*

Educational institutions and businesses impact society since they are part of it. However, the specific identification of impacts on society can foster the development of future sustainable relationships between the institutions [10]. For example, Hazelkorn [11] considers social impacts of research on the quality of life, change in community attitudes, enhanced equity, safety, and security. In the environmental area, pollution reduction, adoption of appropriate recycling techniques, reduction of environmental risks, etc. are the impacts considered. Finally, from a cultural perspective, there is encouraging community creativity, preservation of cultural enrichment, among others.

This perspective of including society as an important agent of research and innovation processes is strongly present in the current Horizon Europe 2021-2027 program, whose objectives are even more challenging since they emphasize the involvement of local communities in R&D projects through public-private collaborations and the engagement of researchers who believe in open collaboration environments, because the purpose is to impact and meet the needs of society [12].

The concept of societal impact in this work is aligned with the one presented by Siemieniako et al. [2], where social impact is identified with the changes experienced in the dimensions of quality of life, culture, health, environment, and politics [13]. The authors organized the concept of social impact into three categories: the micro-level, involving individual social issues; the mezzo level, which includes the social issues stemming from the interaction between members of the organization in close environments, such as the local communities; and finally, the macro level, which considers broader societal impacts, including social issues outside of organizational relationships [2].

Impact measurement that has a quantitative bias reflect a low level of impact that is more concerned with the interests of specific communities, such as industry and science, and focus less on measuring broader social impacts [14]. In this regard, new methods are needed to measure societal impacts, related to poverty reduction and job creation

in communities [1]. The "success map" of Perkmann et al.[15] made a fundamental contribution to the field of study of UICs [5]. Perkmann, et al. [15] highlight dissatisfaction with the existing tools for evaluating the results of UICs, as they focus on participant satisfaction and easily quantifiable results. The authors proposed to analyze collaboration in four stages: inputs, activities in process, outputs, and outcomes. In the final stage, the exploration of the results should generate various impacts related to the emergence of new ideas, innovations in processes, products or techniques, and the benefit of recruiting high-performing professionals [16].

The evidence found in the literature shows a strong trend in investigating impacts from the perspective of industry and university, with few studies explicitly mentioning societal impacts. Authors such as Åström et al. [17], Matei et al. [18] and Gustavsson et al. [19] have analyzed industry and university outlooks on impacts without mentioning impacts at the societal level, whereas Perkmann et al. [15] addressed the industry and social perspective, recognizing that the level of employment or recruitment of graduate and undergraduate students in a context of collaboration can be a social impact. The work presented by Guerrero et al. [20] perceives UICs as value-added generating units that use the knowledge of universities and the skills and experience of the industry to impact society by generating jobs. Xu et al. [21] start from the idea that technological innovation is becoming the main driver of social development. Specifically, the authors demonstrate through spatial econometric models that UICs impact economic development in China through technological innovation.

Sarkies et al. [22] outlined a matrix for assessing the impacts of collaborative health research. The matrix's methodological framework allows them to understand the development of research, policy, health, societal, and economic impacts over time. However, due to the limited time and information available for their research, social impacts related to social equity, knowledge, healthy behaviors and resource allocation were not identified. At this point, it is worth mentioning that studies that have attempted to measure social impact have faced the challenges of finding a measurement approach that considers the long and short term, as well as dealing with impacts that are intangible and therefore cannot be measured directly. Faced with this difficulty, Sairinen et al. [10] recommend the use of different sources of information, such as mixed qualitative and quantitative approaches that allow for a better understanding of the situation before the project and after the project. Table 1 shows key studies on measuring the impact of UIC.

Table 1. Research studies on UIC impact measurement (2000-2021).

| Study of stakeholder perspective | References |
|---|---|
| Studies analyzing impacts of UICs from an industry perspective | [23–38] |
| Studies analyzing the impacts of UICs from a university and industry perspective | [17–19,39] |
| Studies addressing the impacts of UICs from a social perspective | [15,20–22] |

### *2.2. Challenges in measuring the impacts of UIC*

Several authors [15,17,28] agree that impacts are closely related to the time variable, since they can arise during the project, at project-end, years after the project has ended, or even change their nature, from negative to positive or vice versa, over time. The fact that the impact depends on time to be perceived forces us to deal with the phenomenon of "counterfactuality", an issue that for most academics is difficult to deal with since it requires analysis of an unobserved situation.

Some academics addressed the problem of "counterfactuality" using statistical techniques to assay what would have happened if the collaboration had not taken place [27,40]. In contrast Wooding et al. [41] addressed "counterfactuality" using qualitative tools, asking respondents what would have happened if there had been no program and whether they would have achieved the same impacts without the program. The authors mentioned two challenges. The first relates to the transience of the impact, so they suggest using a continuous follow-up mechanism that considers the time needed for the impact to show up. The second relates to the inaccessibility of the impact due to the organization’s political issues [41].

Other challenges of impact measurement are the choice of approach and metrics for short- and long-term measurement [22] and the operationalization and choice of indicators [42]. A recommendation for addressing this problem is the joint work between institutions involved in the collaboration to develop solid methodologies that

describe the impact in a more reliable way [42]. Nevertheless, the task of measuring remains challenging because UICs involve risks, and some of their outcomes, such as the value of knowledge and others stemming from multiple business objectives, are intangible, and thus difficult to quantify [15]. Table 2 presents the challenges found in the literature.

Table 2. Challenges of measuring the impacts of UICs

| Challenges of measuring UIC Impacts | Reference |
|---|---|
| • Some impacts were inaccessible due to guarantees of anonymity and political sensitivity<br>• The transience of impact | [41] |
| • The conceptualization, operationalization, and reliable measurement of each indicator to increase the validity and reliability of the impact evaluation | [42] |
| • The "counterfactuality" | [38,40] |
| • The impact changes over time | [15,17,28] |
| • The choice of approach and metrics for the short and long term | [22] |
| • Quantifying intangible results<br>• High risk of UICs<br>• Quantifying knowledge<br>• Multiple objectives | [15] |

## 3. Methodology

Based on the process presented by Tranfield et al. [43] a systematic review of the literature was applied in five phases: phase I, location of primary studies; phase II, selection and evaluation of studies; phase III, data mining; phase IV, data synthesis; and phase V, result presentation. It is worth mentioning that Tranfield et al. [43] suggest a first planning stage of the systematic review, which would involve the participation of panels of experts and professionals to discuss the review protocol; likewise, in the data mining phase, the authors suggest a process of data mining by means of two reviewers. In the present work, systematic review was planned through periodic meetings held by members of the research team, and data mining was carried out by a member of the research team. In phase I, a set of keywords were divided into five groups (Table 3) and the search was conducted on the Scopus and Web of Science databases, resulting in 368 documents.

Subsequently, three filters were applied for only article-type documents, in English, published between 2000 and 2021. Concerning the latter, the danger of omitting relevant studies is minimized to the extent that recent articles are based on previous studies [44]. The filtering procedure eliminated 175 documents, leaving a total of 193 articles. After eliminating the duplicates, 178 studies proceeded to the next phase II, which included selection and evaluation. Two inclusion criteria were applied in the form of questions: i) Does the study address the impacts of university-industry collaborations as the core of the investigation? and ii) Does the study address mechanisms to measure UIC-related impacts? This process resulted in 44 articles selected for further analysis. Finally, further reading resulted in a sample of 30 articles that passed to phase III, data mining, and then to phase IV for synthesis through conventional content analysis (CA). The CA is mostly descriptive and helps to understand the phenomenon inductively when the theory on the analyzed topic is limited. This process involves dividing the specific elements into groups and establishing the relationship between them, providing a more complete view of the unit of analysis and, consequently, generating new insights from the critical analysis of the data [45].

Table 3. String set of the systematic literature review

| Group | Strings |
|---|---|
| Academy | (“University” or “academic” or “faculty” or “higher education institution") |
| Industry | (“industry” or “enterprise” or “company” or “establishment” or “firm” or “corporation” or “organization”) |
| Context | (“collaborative projects R&D” or “R&D” or “collaboration” or “alliance” or “external partner” or “cooperation”) |
| Object | (“impacts” or “effect” or “benefit” or “outcomes” or “Research output” or “societal impact”) |
| Measurement | (“impact measurement” or “quantifying impacts” or “impact analysis” or “identifying impacts” or “cost-benefit" or “measurement models” or "econometric") |

Consequently, relevant information about the importance and challenges of measuring the impacts of UICs was identified. The main result in phase V is an initial framework with key elements for measuring the impacts of UICs (Fig.1).

## 4. Conceptual framework for measuring the societal impacts of UICs

The framework provided in this section starts with the lifecycle of UIC: inputs, activities in the process, outputs, and outcomes [15]. The interaction of the participants across the lifecycle may generate a set of impacts of different nature, which should affect different communities such as university, industry and society [6]. Focusing on the multidimensional nature of the impacts, an analysis of the literature allowed us to identify three constructs to consider in the process of measuring the societal impact of UICs: ‘context conditions’, ‘methods’, and ‘characteristics’. Each construct is composed of different elements, as shown in Fig. 1.

### *4.1. Nature of the impact*

The literature classifies the impacts of research on society in different ways. The interaction between organizations can generate *positive or negative* effects that can appear in the *short*, *medium or long term*[2]. Other studies consider that social impacts are phenomena that rarely occur in the short term, i.e. they are more common in the medium and long term [3,46]. Another classification is related to the *indirect* way individuals or communities experience the changes generated by UIC [6].

Finally, UICs generate *tangible* or *intangible* results, which are difficult to track and measure [5,15]. Based on the diverse nature of the impacts of UICs, three key constructs have been identified that, according to the literature, must be considered in their measuring process: ‘context conditions’ can facilitate the implementation of ‘methods’, and these two constructs can help develop an impact measurement methodology with the appropriate ‘characteristics’.

### *4.2. Context conditions*

The literature stresses three desired conditions in the behavior of stakeholders involved in collaborative projects. The first is related to the ability to perform *information management* over time. The "success map" proposed by Perkmann et al. [15] highlights the importance of compiling information periodically during the collaboration process, allowing continuous feedback and learning opportunities that can ultimately impact the intensity of the collaboration. Routine collection of information by stakeholders would make it possible to relate the collaboration process to impact [8]. In the same vein, Sarkies et al. [22] mention the need for ex-ante and ex-post reporting to assess societal and other broader economic impacts. *Predisposition to change* among project participants would be the second desired condition for impact tracking. In this regard, Penfield et al. [8] point out that the culture of data collection is an unusual behavior among researchers and professionals, for which it recommends the development and use of electronic tools to facilitate this process. Meanwhile, literature analysis showed that some studies that aimed to measure the impact of collaborative research [22,23,30,32,38] presented common difficulties related to the absence of information in collaborative

projects. In this sense, capturing information about impacts raises methodological, conceptual and practical challenges, so academics have focused on the interaction of different stakeholders, such as researchers and research user communities, to identify how impacts can be investigated and measured [47]. In that sequence, *stakeholder engagement* contributes to the process of generating and measuring social impact. Perkmann et al. [7] define academic engagement as the interactions between academic researchers and other non-academic organizations, such as collaborative research with industry. The authors acknowledge that university-industry engagement generates commercial and research effects, but underscore the need to delve deeper into the social impact that can be generated by socially-engaged universities.

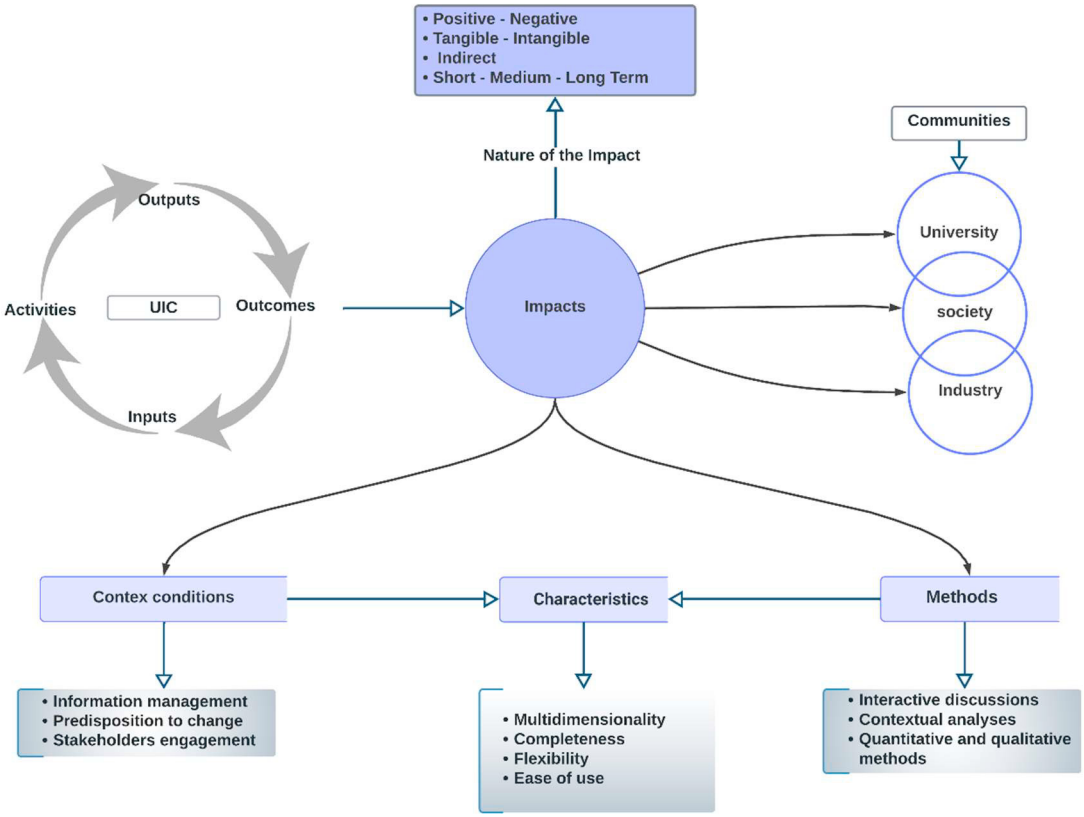


Fig. 1. Initial conceptual framework for measuring societal impacts of UICs.

### *4.3. Methods*

Three methods evidenced in the literature should be followed during the measurement process: encouraging *interactive discussions*, *contextual analyses* in which research projects are developed and *quantitative and qualitative methods*. The first one allows for the multidimensionality of each stakeholder's outlooks, inducing a reflection on the different interests involved [22]. The second facilitates a deeper understanding of the activities, roles, and responsibilities of the impacted communities. The third, use of qualitative and quantitative methods, is relevant for measuring the social impact of research [3]: because of the subjectivity of impacts, it is appropriate to use qualitative metrics such as questionnaires and reports on the outcomes of activities [15]. Along the same lines, Salter and Martin [48] state that many studies that aim to measure the impact of research adopt one of the following three approaches: econometric studies, case studies and surveys (such as the Yale survey, the PACE survey, among others). The case studies provide a more detailed view of the processes that cause the impact [3]. Regarding quantitative methods, such as mathematical, economic, and statistical models, they provide insights into the multidimensionality of the impact

[49]. By following this combination of methods, it would be possible to identify and assess likely impacts over time, and to reach better understanding of the community affected by the project [13].

### *4.4. Characteristics*

The 'characteristics' construct, powered by the 'context conditions' and 'methods', brings together four elements of an impact measurement methodology: *multidimensionality*, *completeness*, *flexibility* and *ease of use*. A model that is acknowledged by academics for its contributions to the measurement of research impacts is the "payback framework" [3]. One of the basic elements of this framework is known as the *multidimensionality* of impacts or benefits. The "payback framework" suggests that impacts should be categorized and then each category is correlated with the phases of the research lifecycle [50]. Multidimensionality in impact measurement can also be applied from the perspective of different tools that are used to collect data and ensure a more complete impact assessment [22].

Considering the multidimensionality of impacts and data collection tools, *completeness* of information is essential for providing a comprehensive picture of impact [8]. During the process of tracking the impact, the researcher addresses three specific problems: where to look for the impact, when was it originated, and was the research project the key factor for the change [47]. Literature mentions some suitable tools for collecting evidence and obtaining a more complete picture of the impact, such as user panels based on interview cycles, case studies, and narratives combined with quantitative tools [8,47,49]. However, these tools should be *flexible* enough for gathering the information on impacts to be used by all stakeholders for different purposes [47]. Among the recommendations presented by Hazelkorn [11] to measure the contribution of collaborative research to society is the application of a multidimensional matrix complemented by a shared information system for gathering and analyzing relevant data, whose *ease of use* should be a characteristic that would enable stakeholders in different scenarios to use it.

## 5. Conclusions

Following a conventional content analysis approach, the systematic literature review presented in this paper has been synthesized to provide a framework with three constructs and some elements to be considered when measuring societal impacts of UICs. This conceptual framework highlights that the complex nature of impacts requires some 'context conditions', 'methods', and 'characteristics' to be taken into account when developing a methodology for measuring the societal impact of UICs.

The three conditions related to *information management*, *predisposition for change and stakeholder engagement* are geared to stakeholders involved in collaborative projects. They are key for the measurement process to achieve the most satisfactory results. This allows the characteristics of the methodology to be developed and the directions to be followed with less effort.

Nonetheless, we acknowledge the limitations of this research study. Although a structured search and analysis process was developed, literature reviews are never completely exhaustive and, therefore, in this process some articles or groups of articles may have been left out of the analysis. Possible exclusions may be the result of several factors: the keywords used, the search query structure, the search scope or other methodological choices. Besides, in the literature analysis process related to qualitative and content analysis, the cognitive bias cannot be fully eliminated. Thus, the results provide suggestions, but they do not limit the constructs and elements discussed in the initial conceptual framework for measuring societal impacts of UICs (see Fig. 1). Overcoming these issues could be seen as opportunities for future research built on the research presented here.

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