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Addressing the Challenges to Successfully Manage University-Industry R&D Collaborations

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Abstract

University-industry R&D collaborations (UICs) are becoming more critical for discovering innovations that can lead to the development of new products, services, and processes and, more broadly, social impact in terms of employment, economic development, and public health. The Covid-19 pandemic, for example, has seen an unprecedented rise in UICs and illustrates how vital their success can be for positively impacting the collaborators involved and society at large. Several challenges face the successful execution of UICs, not the least of which is the cultural difference between the collaborators. Overcoming these challenges is the subject of several research initiatives that seek to identify the critical success factors (CSFs) that UIC consortiums can use to develop their internal capabilities and project management maturity. The challenges facing one large UIC have been studied in Portugal. Practitioners and researchers were involved in generating insights into how the UIC could be more effective. This paper presents some of these challenges facing the UIC and how they were addressed. It also offers early results into the CSFs deemed essential by researchers and practitioners based on their experience together over seven years. Top CSFs include senior management commitment, effective communication, stakeholder engagement, good leadership, clear and realistic goals, mutual trust and respect, interpersonal teamwork, and clear roles and responsibilities.

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1. Introduction

Collaboration between universities and industry in R&D is increasing (UICs) [1, 2] and becoming a critical public policy action to promote innovation [3]. A key obstacle to the success UICs is that universities and industry demand very different types of benefit [4]. Additionally, UICs face challenges associated with high uncertainty and risk, managing creativity and innovation and project members who are often working in different locations [5, 6]. Research literature focuses mainly on the so-called 'cultural gap' between university and industry [7]. The 'cultural gap' includes conflicts over ownership, academic freedoms and differences around priorities, time horizons and research scopes. Many of these conflicts can be mitigated by good project and program management [5, 7, 8]. Program and project management can help smooth out differences between stakeholders through knowledge-sharing activities and helping to define joint project outcomes and expected benefits [9-11]. However, it is well-recognized in the literature that the value of project management is a function of what is being implemented and how well it fits within each organizational context [12].

This paper presents a case study research into practices developed around one major UIC program and discusses how these practices allowed to address the challenges of this type of collaboration and simultaneously address the critical success factors (CSFs) of UICs. A collaborative UIC program is here defined as a temporary organization with a collaborative work environment, within a set of projects related in a specific context, with heterogeneous partners, collective responsibilities, and, in most cases, with public funding support [5, 6].

2. Background

UICs are based on interactive, trusting, and committed relationships between partners, to create mutual value over time, which allows the dissemination of creativity, ideas, and skills, thus promoting a bilateral exchange of knowledge [13]. The production of new results under one or more predefined research objectives occurs within various constraints (time, cost, and resources). It results in a set of benefits for the stakeholders [14]. UICs are crucial for industries to increase their investment in R&D through public funding, perform better in innovation initiatives, share risks, improve resource capacities and skills and overcome competition in the global market [15]. However, despite the multiple opportunities and benefits inherent to UICs, there are several challenges [16], resulted namely from the 'cultural gap'. A comparison of the critical attributes of organizational culture for both a university and an industry is outlined by Ivascu et al. [17] and is presented in Table 1.

Table 1. The critical attributes of organizational culture in universities and industries adapted from [17].

University	Industry	Common orientation
Public mission	Creating value for stakeholders	Creating value for society
Publications	Revenues	Reputation
Project Research	Practical research	Research
Focus on theoretics	Focus on results	Focus of science
Shared resources	Private resources	Competitiveness
Sharing of results	Retained results	Value
Knowledge creation	Capturing knowledge	Knowledge sharing
Open access	Private access	Collaborative innovation
Need for research	Market need	The need of society
Education	Retaining knowledge	Exchange of knowledge

In Table 1, the universities culture is characterized by its public mission, focus on publications, theory building, open access to knowledge, and knowledge transfer through education. Industry culture is characterized by creating value for shareholders, practical or applied research leading to new product or service development, and protecting new knowledge. Both organizations also have common cultural attributes that include a desire to impact wider society, a focus on science and technology and the need to openly innovate with others to tackle complex challenges.

Brocke and Lippe [18] identified several vital challenges for successfully managing UICs. They divided these challenges into three categories:

- Management of research work (e.g., uncertainty about working methods, measurement of project performance, the balance between creative freedom and control);
- Collaboration of heterogeneous project partners (e.g., diversity of individuals, multiple, contradictory stakeholder expectations, the geographic distance of project staff) and;
- Role and skill set of a project manager (e.g., the limited authority of project manager and knowledge gap with individual researchers, diversity of coordinator function).

Several authors pointed important CSFs for collaborative R&D projects, namely mutual trust and respect, senior management commitment, effective communication, stakeholder engagement, good leadership, interpersonal teamwork, qualified and skilled teams, flexibility and adaptability, appropriate methodology for program and project management, regular monitoring and Control, and risk management [7, 19-25]. Recently, Rybnicek and Königsgruber [26] conducted a systematic literature review on the CSFs of UICs, and have categorized the CSFs on: institutional factors, related to the participating partners; relationship factors, related to the linking between those partners; output factors, related to the expected results of the collaboration; and framework factors, related to environmental aspects.

The success of UCIs, as in any type of project, is a multidimensional construct that includes both the short-term project management success efficiency and the longer-term achievement of desired results from the project's effectiveness and impact [27]. Therefore, the success of UICs requires the assessment of the program/ project after its conclusion, allowing the comparison between benefits achieved against those planned [28].

3. Methodology

This study adopted an ethnographic research approach, which entails the exploration and interpretation of a complex case study to generate in-depth knowledge for theory building by researchers who are physically present in the field over a considerable period of time [29, 30]. Several contributions of ethnographic research have been indicated by Moore [31], who explains that ethnography "combines the detailed, experiential perspectives of multiple groups within a social unit, by developing an overarching narrative through participant observation in these groups, to obtain a fragmented and integrated perspective on the social unit". Therefore, the research strategy adopted is a longitudinal case study, with an exploratory orientation [32]. It is argued that the behavior of the project participants within their real-life settings can be best captured through an in-depth longitudinal case study [33]. The case study used is characterized as a major UIC involving a large multinational corporation – Bosch Car Multimedia Corporation (Bosch), one university – University of Minho (UMinho) and a Portuguese government funding agency. The UIC program of R&D projects was carried out in three separate phases of work activity between 2013-2015, 2015-2018, and 2019-2021. The first phase was called HMIExcel. After the success achieved with this R&D program [34], the collaboration moved forward in 2015 with a new program, named INNOVATIVE Car HMI, which also presented excellent results in June 2018. In July of the same year, the collaboration moved on to the 3rd and current phase, with three R&D programs in parallel: Sensible Car, Easy Ride, and Factory of the Future. The critical application domains for individual R&D projects in the program were electronics and instrumentation, information technology, mechanical technologies and materials, industrial engineering and management, and optical physics. Since 2013, the beginning of the collaboration, more than 170 million euros have been invested in creating solutions for mobility and connected industry, creating critical knowledge that actively contributes to increasing the competitiveness of Portugal in the global market.

A small team of researchers studied the UIC program over seven years, since 2014. During these periods, the insider had her own physical workplace at the office, close to the Program and Project Management Office (PgPMO)

team. She interacted with all primary decision-makers and observed at close quarters challenges and successes within the consortium. The observations of the insider included daily practices and the evolution and interactions of different actors and institutions of the collaborative organization at different levels. The other authors acted as outsiders who reflected on observations from a distance [35]. Data collection involved observation and participation and included collecting various types of qualitative (semi-structured interviews and focus groups) and quantitative data (surveys). The insider researcher recorded observations about daily work routines, workshops, and meetings at all levels and informal discussions during members' day-to-day activities.

4. Findings

The UIC faced six key challenges, also previously acknowledged by Brocke and Lippe [18]. Table 2 summarizes the main challenges and the solutions implemented by the UIC, as well as the publications around the implemented solutions for more details.

The first challenge (C1) addressed uncertainty about working methods and expected results. This challenge was tackled by the adoption of a Program and Project Management (PgPM) approach (R1) with well-defined program and project life cycles [36-38]. UICs are usually regarded as projects by the funding entities and partners. However, due to its large scale, complexity and uncertainty, the consortium managed the UIC as a program. A program is a set of projects that are somehow related and that contribute to the same overall strategic goals [39]. Fundamental differences are found in the way projects and programs are managed, namely in response to uncertainty and change [40]. Programs require a specific form of thinking - more tolerant of uncertainty, embracing change, and more aware of business influences [41]. Implementing the PgPM approach allowed the UIC, to address several CSFs, including: stakeholder engagement; clear and realistic goals; clearly allocated resources; updated work plan and deliverables; regular monitoring and control; learning and benchmarking; realistic schedules; risk management; adequate budgeting; no hidden agendas; and effective change management.

Table 2. Main challenges and solutions for collaborative university-industry R&D programs.

Challenges	Solutions	See publications for more details
C1: Management of research work - uncertainty about working methods and expected results	**R1:** Program and project management (PgPM) approach	[36-38]
C2: A governance and management approach to balance between creative freedom and control	**R2:** PgPM a hybrid management approach	[42]
	R3: Governance model	[43]
	R4: Evolutionary governance	[44, 45]
	R5: PgPMO roles to support UICs	[46]
C3: Multiple, contradictory stakeholder expectations	**R6:** Benefits management framework	[14]
	R7: Critical factors for benefits realization	[47]
C4: Measurement of project performance	**R8:** Method for measuring the performance of UIC	[48]
C5: Role and skill set of project manager, namely limited authority, diversity of coordinator function	**R9:** Demonstration of the value of project management to UIC	[49]
C6: Geographic distance of project staff	**R10:** A conceptual social media tool for supporting UIC	[50]

The second challenge addressed the need for a governance and management approach to balance creative freedom and control (C2). The solutions implemented (R2-R5) ranged between promoting trust among participants by the

establishment of a governance model [17,18], a hybrid approach to project management, taking into account transversal and contingent practices [42], and the structuring of the Program and Project Management Office (PgPMO) with clear roles and responsibilities [46]. The establishment of a governance model [43] promoted good governance [44, 45] and allowed the clarity of roles and responsibilities among all parties involved [43], both understood as CSFs in UICs [7, 22, 24]. The adoption of the PgPM hybrid management approach emerged from the desire to realize the benefits of the agile approach while retaining part of the structure of waterfall approaches [51]. This allowed the employment of an appropriate methodology for program and project management, giving the flexibility to project planning and adaptability to change [7] and promoting interpersonal teamwork [21]. The PgPMO enabled effective, open and constant communication and information sharing [7, 19], minimizing the conflicts among stakeholders [20, 24]. For example, universities aim to share research results as soon as possible through publications, and industries aim to retain results as much as possible to increase revenues. The PgPMO promoted effective communication that focused participants on increasing value, namely for society, as these programs were also publicly funded.

A third challenge was related to the heterogeneity of employees and the multiple and contradictory expectations of stakeholders (C3). The solution focus was the definition and realization of benefits, culminating in a framework for benefits management (R6) [14] and the definition of CSFs for the benefits realization (R7) [47]. The benefits management framework fostered a long-term perspective on the benefits resulting from the consortium [14], a balanced adjustment between the university and the industry interests, mutual benefits realization aligned with each partners strategy [19], and the common orientation towards the creation of value and value for society [17].

The fourth challenge related to performance measurement (C4) encouraged the elaboration of a method for managing performance indicators taking into consideration the different life-cycle phases of the program (R8) [48]. The application of the performance measurement method during the second R&D program execution promoted adjustments and improvements to the initial orientation of the program, i.e., promoted flexibility and adaptability a crucial CSF of UICs [7]. It also led directly to the UIC agreeing to extend the partnership for a new third and currently on-going phase, through an investment of over €100M.

The fifth challenge questions the role of project management (C5), and this resulted in the demonstration of its value for each group of stakeholders through the creation of a value framework of project management in UICs (R9) [49]. The value framework allowed to make aware each of the key stakeholders (i.e., university, industry, university-industry consortium, funding entity, and external R&D entities) the view of the different values resultant from project management practice, thereby minimizing the resistance for use of an appropriate methodology for program and project management [7], standardizing project management practices for all projects in the program, such as the project charter, progress meetings or the close report. Additionally, it allowed stakeholders to identify, select, manage, and review the values resultant from UIC.

Finally, the sixth challenge of geographic distance (C6) introduced the possibility of using social media tools for stakeholder integration (R10) [50]. It specified the main objectives and requirements of the social media tool. The social media tool was later deemed unnecessary for implementation in the UIC. One of the main reasons for this was the level of investment needed to develop the tool. However, in addressing this challenge, the University partner created a sizeable physical space on its campus available to all project teams members to promote team interactions, exchange of knowledge and team building, also all-important CFSs of UICs [7].

A total of 42 individual CSFs can be attributed from the ten solutions discussed above. University researchers and Industry practitioners were later asked to rank the CSFs in order of their impact on the effectiveness of the UIC on a scale from 1 (very low) to 5 (very high). Table 3 presents the 42 CSFs (in summary notation) and the average scores by all University participants (U), all Industry Participants (I) and both (U&I). A total of 14 individuals participated – nine from the University and five from the industry. There is an explicit agreement by all participants on the top eight CSFs. There is some disagreement among University and Industry participants on the impact of some of the CSF's (e.g., qualified, and skilled teams; mutually agreed and updated work plan and deliverables; collaboration champions; corporate stability and market; and equality of power and dependency). There is also reasonable agreement from all participants on CSFs that had the most negligible impact on the effectiveness of the UIC (e.g., previous collaborations and experiences; appreciating different viewpoints; no hidden agendas). It is beyond the scope of this paper to discuss the findings of this research results in detail.

Table 3. Critical success factors in order of average score by all participants.

Critical Success Factors	U Avg.	I Avg.	U&I Avg.
Senior Management Commitment	4.7	4.8	4.7
Effective Communication	4.7	4.6	4.6
Stakeholder Engagement	4.6	4.4	4.5
Good Leadership	4.6	4.4	4.5
Clear & Realistic Goals	4.6	4.2	4.4
Mutual Trust and Respect	4.6	4.2	4.4
Interpersonal Teamwork	4.3	4.0	4.2
Clear Roles and Responsibilities	4.2	4.0	4.1
Qualified and Skilled Teams	4.6	3.4	4.1
Clearly Allocated Resources	4.2	3.8	4.1
Competent Program and Project Managers	4.4	3.4	4.1
Appropriate Methodology for Program and Project Management	4.2	3.8	4.1
Balanced Benefits Realisation	4.3	3.4	4.0
Motivation and Engagement	3.9	4.2	4.0
Complementary Expertise	4.0	4.0	4.0
Mutually agreed and Updated Work plan and Deliverables	4.3	3.4	4.0
Learning and Benchmarking	4.1	3.6	3.9
Mutual Benefits and Aligned with Partners' Strategy	4.2	3.4	3.9
Good Governance	4.1	3.4	3.9
Shared Vision and Goals	4.0	3.6	3.9
Realistic Schedules	3.6	4.2	3.8
Regular Monitoring & Control	3.8	3.8	3.8
Risk Management	3.6	4.0	3.7
Effective External Subcontracters	3.9	3.4	3.7
Mutual Understanding of Partners' Needs	3.8	3.6	3.7
Long-term Perspective	3.6	4.0	3.7
Political Support and Funding	3.4	4.0	3.6
Adequate Budgeting	3.8	3.4	3.6
Effective Conflict Management	3.6	3.6	3.6
Adaptive Cultures	3.6	3.6	3.6
Collaboration Champions	4.0	2.6	3.5
Interactions Between Projects	3.6	3.4	3.5
Equality of Power and Dependency	3.9	2.6	3.4
Reputation of Stakeholders	3.4	3.4	3.4
Training Provision/ Team building	3.6	3.2	3.4
No Hidden Agendas	3.3	3.4	3.4
Flexibility and Adaptability	3.6	3.0	3.4
Effective Change Management	3.4	3.0	3.3
Corporate Stability and Market Needs	3.9	2.2	3.3
Researchers Interactions with Industry Partner	3.1	3.6	3.3
Previous Collaborations & Experience	3.2	3.2	3.2
Appreciating Different Viewpoints	3.3	2.8	3.1

5. Conclusions

This research provides some new insights into the challenges, potential solutions and critical success factors (CSFs) that support UICs to reach their full potential. These help to reduce the 'cultural gap' among collaborating partners. Some the practices identified are widely used in other project contexts, while others are new to the specific context of UICs. The success of the collaboration between Bosch and UMinho is demonstrated in terms of technical-scientific production indicators and the agreement of a third phase of collaboration currently running. Many of the solutions and operationalization of CSFs can lead to creating sustainable and long-term models of UICs.

UIC and their constituent partners present many different cultures, practices, competencies, and mindsets. Further research is still needed to understand how program and project management can help to reduce this gap so that industries can strengthen their perception of universities as effective partners – rather than suppliers – and that in turn, universities can adapt and orient more towards applied and translational research that meet the actual needs of industry and society. Future research is needed to understand the degree of knowledge heterogeneity between the UI partners, strengthen cultural differences and empower multicultural teams. Future research will be conducted using Interpretive structural modeling [52] to understand the contextual relationship among the CSFs and extract the essential factors that increase the success of UICs. Interpretive structural modeling develops a hierarchical structure for analyzing the interactions among CSFs.

Additionally, there is also more research required on the tools and methods to measure UIC benefits and societal impact. The cooperation between universities and industries is now strongly encouraged by governments to enhance national competitiveness and wealth creation, thus widening the focus beyond innovation and towards broader societal impact. UICs, for their part, also need to address the various ways wider society benefits from research. Therefore, future research might include measuring the success or otherwise on the societal impact of UICs.

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