Value of project management in university -industry R&D collaborations

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Abstract

Purpose – University-industry projects provide special challenges in understanding and expressing the values required of project management (PM) in delivering stakeholder benefits. This paper presents a framework for understanding, identifying and managing the values of PM in major university-industry R&D projects.

Design/methodology/approach – The value framework identifies for each of the key stakeholders, the key PM values that may require to be managed and largely derived from research literature. Empirical research then explores, prioritizes and selects key PM values that need to be managed for a specific project. A large case study is used involving one university and one industry collaborating on a multi-million Euro initiative over six years. Empirical research was conducted by researchers who observed at close quarters, the challenges and successes of managing the competing values of key stakeholders.

Findings – The value framework takes a stakeholders' perspective, by identifying the respective PM values for each of six stakeholders: university-industry consortium, university, industry, R&D external entities, funding entity and society.

Practical implications – Guidance and decision support is provided to multi-stakeholder research consortia when selecting values that need to be managed for achieving tangible and intangible project benefits.

Research limitations – The research was performed using only one case study which limits the generalizability of its findings, however the findings are presented as a decision support aid for project consortia in developing values for their own collaboration.

Originality/value – The paper demonstrates a proposed framework for designing and managing the value of PM in large multi-stakeholder university-industry R&D projects.

Keywords: Project management, value, collaborative research, project stakeholder management

1. Introduction

University-industry R&D projects have grown considerably in number in recent years in the search for new knowledge (Ankrah and Al-Tabbaa, 2015; Barnes *et al*., 2006; Perkmann *et al*., 2011). In most developed economies governments provide significant funding for Research and Development (R&D) that incentivises collaboration and knowledge exchange between private industry and universities (López, 2008). These investments are made principally to help create innovative solutions that will result in widespread economic growth. Investment is also made with the expectation that such projects will improve knowledge and long-term innovation capacities of the collaborating partners.

Project Management (PM) is regarded as a critical factor for managing the success of university-industry projects (Barnes *et al*. 2006; Huang and Chen 2017). The value of PM is measured not only in terms of meeting project objectives on-time, within budget and with a satisfactory level of quality but also meeting other tangible and intangible values defined by key stakeholders. These values of PM include the achievement of long-term benefits beyond the life of the collaboration (Mir and Pinnington, 2014) such as the alignment of PM with each organization's strategy (Mir and Pinnington, 2014; Fernandes *et al*., 2014). Moreover, according to Eskerod and Riis (2009), enhanced PM is the most significant element in bringing value to all project's stakeholders. The PM approach to processes, methods, instruments, attitudes, and behaviour lead to values in

the form of greater communication, more efficient use of resources, higher customer satisfaction, easier knowledge sharing and improved future possibilities.

It should be noted from the outset that, although related, the concept of 'values of PM' is different from the 'values of an organization'. Organizational values are an expression of deeply held beliefs such as those around equality, access and quality that underpin strategic intent. For example, one may assume that in most university-industry collaborations, the value of 'collaboration' is a deeply held belief even if often implicit and unexpressed. This research is about the values of PM in such a collaboration related to the explicit and implicit functions of PM. According to Meredith and Mantel (2012, p. 9), "the most crucial attribute of a project is that it must be important enough in the eyes of senior management to justify setting up a special organisation unit outside the routine structure of the organisation". The value of PM therefore includes not only the realization of the project goals but also comprises the sum of PM values derived from all of the stakeholders (Zhai *et al*., 2009). Laursen and Svejvig (2016) define PM value as the quotient of satisfaction of needs and use of resources implying that the perception of value depends on multiple stakeholder perspectives (Morris, 2013). On the other hand, Cooke-Davies *et al*. (2009) argue that the value of PM is created or destroyed depending on the extent of 'fit' or 'misfit' between the organization's strategic drivers and the characteristics of its PM system. Thus, the strategy of the organization or organizations influences what is perceived as value, how outcomes are achieved and reported and what projects to undertake. Value in this context is the regard that PM is held by different collaborating stakeholders related to its importance, worth, or usefulness for a particular endeavour.

A key consideration underpinning this research is that realizing PM values beyond managing cost, time and quality may require the justification of additional incremental investment. The value of investing in enhanced PM has been difficult to define and measure (Thomas and Mullaly, 2008), and therefore it is difficult to convince key stakeholders about the value of PM (Kwak and Ibbs, 2000).

In collaborative university-industry R&D, this is a particular concern since the end results are difficult to predict and there are various stakeholders with different objectives and expectations (Barnes *et al*., 2002); and therefore the value of PM for R&D collaboration projects has been argued (Benner and Tushman, 2003; Du *et al.*, 2014; Shenhar and Dvir, 1996). Thus, the main purpose of this research is to answer the question:

What are the key values of PM in a university-industry R&D collaboration?

To address this question, the authors have engaged in a four-year longitudinal case study of a major R&D collaboration between University of Minho (UMinho) and Bosch Car Multimedia (Bosch) in Portugal. This case entailed two investment phases from 2013 to 2018, with a total investment of more than 70 million Euros.

This research methodology involving such a large case study over a prolonged period not only helped to answer the question 'what?' PM values were important but also 'how?' they could be defined and managed in the case study scenario (Saunders *et al.*, 2016) and therefore applicable to broadly similar R&D collaborations.

The paper begins with a literature review of collaborative university-industry R&D around the concept of PM value. It then describes the research methodology deployed in greater detail and that includes a major case study analysis. The paper then

presents research findings in the form of a PM Value Framework for university-industry R&D collaboration projects. The research findings present the results of semi-structured interviews designed to enhance and improve the conceptualization of the PM Value Framework. The mains strengths and limitations of the proposed framework are discussed, as well as a method for applying the framework. Finally, the last section provides the conclusions of the study accompanied by the research limitations and suggestions for further research.

2. Literature review

2.1 Collaborative university-industry R&D

Increasing competitiveness of new science-based industries have led to a decentralized industrial research process, where external sources of research skills and knowledge, such as from universities, have gained importance in the eyes of industries (Sá and Litwin, 2011). Scandura (2016, p. 1907) argues that "In today's fast changing knowledge economies, firms need to find and exploit new sources of knowledge in order to innovate and grow" and in a similar vein: "Knowledge and technology transfer between academia and industry is expected to spur innovation, as this kind of collaboration combines not only heterogeneous partners, but more importantly, heterogeneous knowledge" (Rajalo and Vadi, 2017, p.42). Collaborative university-industry R&D is, therefore, a way for firms to obtain expertise that cannot be generated in-house and offering the possibility of efficient knowledge transfer, resource exchange and organizational learning (Becker and Dietz, 2004).

According to Brocke and Lippe (2015, p.3), a collaborative research project is a temporary organization, characterized by heterogeneous partners, with the purpose of "building and evaluating novel results under pre-defined research objectives and with constraints on resources, cost and time". Commonly, university-industry collaboration R&D projects are also publicly funded, operating a 'triple helix' relationship between university, industry and government (Etzkowitz, 2003), where industry operates as the locus of production, the university as a source of new knowledge and technology, and the government as the source of contractual relations that guarantee stable interactions and exchange. Collaborative R&D projects are one of the main channels of university-industry interactions with other types of interactions including human resources mobility, networking, information diffusion (through journals, reports, conferences), training and consultancy, property rights, incubators, and spinoffs (De Fuentes and Dutrénit, 2012).

Industry faces a major paradox in entering such collaborations since universities, although providing complementary knowledge, can be a challenging partner to work with (Steinmo and Rasmussen, 2016). Since both partners have different systems of knowledge production, there is a high chance of conflict or misunderstandings between partners during the collaboration (Bruneel *et al*., 2010). On one hand, free and open communication of research results is crucial for the objectives of knowledge production and dissemination of universities. On the other hand, the protection of information is essential for the financial objectives of firms (Hemmert *et al*., 2014). Thus, "Transformation of values of organizations and individuals is necessary for university-industry cooperation" (Nomakuchi and Takahashi, 2015, p. 48).

According to Ankrah *et al*. (2013), it is important to understand the motivations behind collaborating actors since they can indicate anticipated project values. In this sense, Ankrah and Al-Tabbaa (2015) identified the exposure of students and faculty to practical problems, the access to complementary expertise and up-to-date equipment and facilities, and the employment opportunities for university graduates. Other values include potential growth in new knowledge, the publication of scientific papers, the promotion of innovation and the contribution to regional/national economy. Efficiency is a major concern for industries. Thus, industries often collaborate with universities in order to save costs, benefit financially from research results, enhance its technological capacity and economic competitiveness, shorten its product life cycle, develop its human capital, and to obtain national incentives for developing such collaborations. In addition, they obtain solutions to specific problems, subcontract R&D, reduce and share risks, enhance its corporate image and have access to research networks, new knowledge, cutting-edge technology, expertise and complementary know-how (Ankrah and Al-Tabbaa, 2015).

Although the specific motives and outcomes of university and industry actors differed, at the aggregated level both groups displayed similar profiles (Ankrah *et al*., 2013); for example, Fernandes *et al.* (2017) identified reputation growth, new business opportunities, and economic growth and wealth creation.

Barnes *et al.* (2006, p.399) raised the importance of a "project manager to harmonize the differing objectives, perspectives and modes of operation of often diverse organizations" and PM as a success factor for set-up and execution of collaborative R&D projects. However, many university-industry collaboration projects fail to deliver project results (Huang and Chen, 2017). Thus, it is necessary not only to implement PM

practices (Chin *et al.*, 2011) but importantly, to demonstrate the value of these PM practices to the key stakeholders involved in order to facilitate their effective embedment in the university-industry consortium (Fernandes *et al.*, 2014). When two entities agree to collaborate, a temporary organization is established which is represented by the dimension 'consortium'.

Much has been written about the value of PM within the organizational context, however, there is still a gap to be tightened regarding the project level and the value of PM across the context of R&D projects that has been put into question by several researchers (e.g., Benner and Tushman, 2003; Du *et al.*, 2014; Shenhar and Dvir, 1996).

2.2 Value of project management

PM needs to manage distinct values for different organizations and projects (Zhai *et al*., 2009). The value of projects is a broader subject in the sense that it can be associated with concepts such as PM performance and project success (Mir and Pinnington, 2014), PM maturity and project effectiveness (Ibbs and Reginato, 2002; Kwak and Ibbs, 2000; Brookes *et al*., 2014), and PM improvement efforts (Andersen and Vaagaasar, 2009; Fernandes *et al*., 2019). According to Jugdev and Muller (2005), if project success is limited to the variables of cost, time and scope, also known as the iron triangle, then PM is perceived as providing operational value. Therefore, in order to have strategic value, a clear connection must be made between how efficiently and effectively a project is done, and how the project's products and services provide business value (Turner and Xue, 2018).

Thomas and Mullaly (2007) identified three main approaches for determining the value of PM: the Return on Investment (ROI) approach, the Balanced Scorecard approach, and the competency-based perspective approach. ROI approaches are based on the financial value and include the calculation of the cost-benefit ratio, ROI, and maturity-based ROI metrics. The concept of maturity refers to a stage where the organization is in a perfect condition to achieve its objectives. Thus, PM maturity is the position in which the organization finds itself regarding the PM processes (Thomas and Mullaly, 2008).

Lappe and Spang (2014) found a clear relationship between the investment in PM and the benefits resulting from its application. The findings show that at least one cost dimension (organizational costs, investment in PM optimization and project costs) determines each benefit dimension (tangible and intangible). Ibbs and Kwak (2000) proposed a procedure for calculating the ROI of PM using the cost index, the current profit margin, and the PM maturity level that the organization seeks to attain to calculate an estimated project profit return that can be achieved by moving to a different PM maturity level. Ibbs and Kwak (2000) observed some positive tendencies between high PM maturity levels and better cost and schedule index, although none of the relationships was statistically significant. Spalek (2014) demonstrated that a change in the maturity level reduces the cost of forthcoming projects with different degrees of intensity, depending on the PM maturity and industry type.

According to Ibbs and Reginato (2002), the key is to build competence in PM and then focus on reducing its costs. As the organization implements PM practices, the organization starts increasing, not only its maturity, but also its expenditures in PM. At the initial stage, its returns are low, and therefore the organization actually spends more

than it gains. When the organization is more mature, and its procedures are implemented with the goal to maximize the efficiencies of PM, the cost of PM decreases.

As Zhai *et al*. (2009) argued, not everything can be translated into monetary terms, therefore other approaches have emerged. For example, the Balanced Scorecard approach uses financial and nonfinancial measures such as learning and growth, customer perspectives, financial perspectives, and internal measures. The Competency-Based Perspective approach emphasizes the impact that internal competencies have on competitive advantage. Thomas and Mullaly (2007) go further and developed a five-level framework which identifies different types of organizational value. The authors include not only ROI but also aligned use of practices, process outcomes, business outcomes and satisfaction of stakeholders.

Mullaly and Thomas (2009) observed that in a number of cases, there was a strong degree of alignment and consistency in adhering to defined PM practices, but the demonstrated value of the PM implementation was relatively low. Therefore, it is highly important the 'fit' of what has been implemented needs to be appropriate to the organization and the types of projects they manage (Mengel *et al*., 2009). Moreover, since different capabilities are required at different times in an organization's evolution, a capability that will be of value at one stage will not be appropriate at an earlier or later stage of the organization evolution. Thus, the idea of 'fit' is dynamic and raises the notion of value direction (Mullaly and Thomas, 2009). Value direction is, according to the authors, the ability of a PM implementation to continue to deliver value in the future.

According to Shi (2011), one of the basic conditioning factors for PM to create value is the way it is implemented in an organization. The author argues that improving both hard and soft systems synchronously will improve the value of PM and therefore, bring value to the organization. The configuration of soft system refers to the general environment of the implementation of PM and comprises the general management system and the culture of PM. The configuration of hard system comprises the PM process, tools and techniques, training and, knowledge management.

Improving PM can result in several different business outcomes depending on the nature of the organization. On one hand, companies that do projects for clients may improve customer satisfaction and their ability to attract new customers. Manufacturing industry and research projects for product development may improve project delivery speed and reliability, and organization's time to market performance. On the other hand, companies that do projects for internal purposes can benefit from increased ability to achieve strategic goals reliably (Thomas and Mullaly, 2007). Mengel *et al*. (2009) identified client satisfaction, greater project transparency, better project performance and improved project control as the most important process outcomes common to most organizations.

In order to analyse the satisfaction of stakeholders, a key question arises "Do the key stakeholders perceive that PM provides value?" (Thomas and Mullaly, 2007). People are recognized as the most important entity that can contribute to the success of the organization through their level of motivation and their strategic deployment. Therefore, people's sense of satisfaction and dissatisfaction is a crucial factor when it comes to the perceived value of PM (Mengel *et al*., 2009). Zhai *et al*. (2009) developed a framework that measures the value of PM through stakeholders' perspectives. The

framework defines four dimensions: enterprise, customers, community, and subcontractors/suppliers as key stakeholders of mega-projects. Zhai argues that the value of PM comprises both tangible and intangible benefits. On one hand, PM will lead to increased revenue, reduced costs and time saved. On the other hand, the organization will see, for example, improvements in quality, corporate competences, and satisfaction of customers, suppliers, subcontractors and employees. However, only if managed effectively, will PM promote economic and social development and foster PM talents (Zhai *et al*., 2009).

Later, Mullaly (2014) analyzed the relationship between tangible and intangible value and the levels of maturity in PM. The attainment of tangible value can be assessed and measured in financial terms and includes revenue increases, customer retention, cost savings, increased customer share, reduce waste and rework, and greater market share. On the other hand, intangible value reflects strategically important dimensions of value that cannot be expressed financially, such as attainment of strategic objectives, more effective human resources, improved overall management, improved corporate culture, improved reputation, improve regulatory compliance, improved competitiveness, among other. Mullaly (2014) observed that the percentage of organizations perceiving tangible value was relatively small. The opposite was observed for intangible value, where a comparatively larger number of subtypes and a larger number of organizations realizes this category of value. Moreover, it was concluded that peak levels of tangible value emerged at low maturity levels and that levels of intangible value progressively increase at each level of maturity.

3. Research methodology

This research followed a single case study design, exploring the way the key stakeholders' in a major university-industry project perceived and managed the values of PM. Case studies are one of the most used research strategies for similar research endeavours (Yin, 2014). By using it, researchers can focus on a particular phenomenon and discover crucial knowledge (Saunders *et al*., 2016). The research used a deductive approach to inference, drawing on theory from a wide number of sources (see Table I) and exploring it in a major case study (Bitekhtine, 2008). This was followed by the collection of empirical data and the development of researcher experiences and interpretation of the phenomenon reported.

3.1 Case study

The research was conducted over a four-year period up to 2018 and was based around a six-year R&D collaboration project between the University of Minho (UMinho) and Bosch Car Multimedia (Portugal). The first phase involved an investment of €19.2 million and the participation of around 300 researchers from UMinho and collaborators from Bosch who worked on 14 individual projects managed under a program. The second phase involved an investment of €54.7 million with around 500 people involved from both partners, who worked on 30 projects.

Bosch and UMinho initiated a partnership through a 'memorandum of understanding' that was an official agreement to collaborate on R&D activities. The overarching goals for the collaboration were for Bosch, not only to increase its

international accumulated sales volume, but also to diversify its business and products, and consolidate its reputation among customers and within the Bosch Group. The goals for UMinho were to improve its reputation in the scientific community and strengthen the scientific and technological knowledge transfer to industry (Fernandes *et al*., 2017).

During both phases of investment, the collaborators from the industry side identified several specific issues or innovative needs to be addressed based around Bosch's strategic goals. These demands resulted in the development of a one-page documents named the 'innovation idea papers'. One of the duties of the UMinho program coordinator team was the selection of faculty members responsible for exploring the issues or generating innovative ideas that would later be reformed as project ideas. Focusing on project ideas, these faculty members developed their own research teams at UMinho. In close collaboration with Bosch, these research teams developed 'project idea papers' out of the initial 'innovation idea papers'.

Based on the 'project idea papers' developed by the different project idea teams, the 'funding application' was shaped. After the approval of the 'funding application', the two partners and the government negotiated on the signing of the program's 'funding contract'. Key participants then started negotiations on the structure of governance of the program and its projects. Therefore, a clear definition of the roles and responsibilities of each participant for the execution phase was established.

A Program and Project Management Office (PgPMO) was formed with members from Bosch and UMinho. The ultimate aim of the PgPMO was to translate strategies by both parties into project ideas. The project teams also emerged through the selection of

Project Leaders, as well as, the transformation of the program coordinator into the Program Manager.

The collaboration adopted a bespoke PM approach developed by Fernandes *et al*.(2016) which divided the PM life-cycle into 4 phases: project initiation; project initial planning; project execution, monitoring and control; and project closure.

During the project initiation, the key stakeholders of the projects were involved in 'alignment workshops', organized by the Program Manager, with the aim of aligning the expectations and objectives of the involved collaborators before receiving the project funding. There was an interval of more than one year between the emergence of project ideas and the effective project initiation, and the influence of this gap was mitigated through these 'alignment workshops'. These workshops allow the promotion of feedback to the university project teams on the industry's needs, and facilitate interactions with different functional areas within the industry. Then, the 'project charters' for each project were created, with the support of the PgPMO, aligned with the overall program aims, identifying the objectives, expected benefits, deliverables and innovative characteristics of the projects established in the 'funding application'.

During execution phase, one of the major challenges was the balance between creative freedom and control. The project teams had freedom to develop and organize their work (informal management on the micro level). But a major activity during this phase was the monitoring and controlling of the program by the Program Manager through the PgPMO (formal control on the management level). Status meetings were held monthly between the PgPMO and project teams, resulting in 'project progress reports'.

In order to inform the government of the progress, semi-annual 'technical and financial progress reports' were developed by the PgPMO. In addition, the government carried out independent annual 'audits' at Bosch headquarters, where the overall intermediate results were presented by the Bosch Program Manager and the intermediate results of each project were presented by UMinho and Bosch Project Leaders; and the PgPMO developed and managed repositories that provided relevant information from past and current projects, and provided knowledge management for all the members of the consortium. Moreover, during the execution and closing phase, great effort was made by the PgPMO team to identify, document, analyze, store and retrieve the lessons learned from each project and to the overall program.

Finally, the R&D collaboration was accomplished within scope, time, cost and quality, and several mid and long-term benefits were also achieved. Stakeholders showed high levels of satisfaction, not only for the whole R&D program but also with the projects that they were involved with (Pinto *et al.*, 2016).

3.2 Data collection and analysis

The chosen research methods were document analysis, participant observation and semi-structured interviews. The document analysis involved the development, execution and progress of key PM policies including the governance model, the roles of the Project Management Office, as well as several documents that supported the management of the overall R&D collaboration initiative (managed as a program) and its constituent projects (e.g., project charters, technical and financial progress reports to the funding entity and the reported benefits realized over time). In addition, two online

surveys were conducted, at the end of each phase of investment, that identified the perceived most useful PM practices, and overall stakeholders satisfaction.

Observation played an important role in the context of this research and involved a sizeable amount of onsite observation (Alvesson and Sköldberg, 2017). The approach builds on the researchers ability to have close contact with project participants in their native environment and in turn be able to understand the PM from their perspective (Baker, 2006). Observation is characterized by being participative, since the researchers are inserted in the group and participate in the activities observed (Saunders *et al*., 2016).

Researchers observed key stakeholders in naturally occurring situations, namely during daily work routines, workshops, celebrations and meetings at every organizational level, as well as informal gatherings during the daily activities of the members. Several written field notes were prepared during the participation observations. Each of the notes consisted of numerous informal interactions with the staff during the day and related reflections. Among other things, these observations included more than 400 meetings. Listening to and questioning collaborative program participants and their conversations provided information about everyday organizational life and the emerging practices of collaboration. Participative and systematic observation, analysis and interpretation of behaviour, over a four-year period made it possible to better realize and perceive the value of PM in this particular context.

Observation is often criticized for a potential lack of reliability (Saunders *et al.* 2016); yet, coupled with other qualitative methods, it is an important holistic research method, which enables the researchers to gain a better understanding of the context

(Baker, 2006). Therefore, besides participant observation, the case study analysis was primarily informed from twenty-seven semi-structured interviews with three program managers, seven project managers, ten PgPMO members and seven project team members. The selection of the participants took into consideration their diversity, role, contractual position, and experience in university-industry collaboration projects.

These interviews are of benefit by providing a systematic collection of participants experience, interpretation and feelings within their natural setting on the PM values in university-industry R&D collaborations. The interviews were conducted in-person at the university campus and in the industrial organization. Each interview started with an introduction and an outline of the main objective of the study, and consisted of the following questions:

- Describe your experience in PM.
- Describe your experience in university-industry projects.
- Who are the key stakeholders in university-industry projects?
- What are the values of PM in the university-industry collaboration projects?

The objective of the first two questions was to characterize the interviewees. The third and fourth questions identified and validated key PM values. When necessary, supplementary questions were made to obtain more detailed responses. After the first six interviews, the researchers noticed that, in order to have a more detailed answer about the PM values, they should directly ask about each PM value identified in the 'Value Checklist' developed as a result of participant observation, document analysis and literature review (see Table I). The interviews lasted between thirty minutes and one hour. All interviews were recorded and later transcribed to generate a written interview

report. After the period of interviews, the written interview notes were sent, by email, to respondents for validation and possible additional comments.

4. Research results

The results of this research are presented in two stages – the development of a 'Value Checklist' and a 'Value Framework' informed by key stakeholders. The 'Value Checklist' was derived from research literature, participant observation and document analysis and involved two dimensions – identification of stakeholders and identification of key PM values written as statements or definable performance indicators. The literature review was conducted on research papers published between 2000 and 2017. The papers were selected by means of the search engines Science Direct and Scopus using the keywords: "project management value"; "project management values"; "project management benefits"; and "university-industry benefits". 42 papers were selected after an initial screening, reduced to 14 papers after the final screening. This analysis resulted in gathering a list of values attributed to PM or 'Value Checklist'. The 'Value Checklist' was then used to generate a 'Value Framework' following semi-structured interviews of key stakeholder groups from the university and industry.

4.1 Value checklist

Several authors have attempted to determine, understand or express the value of PM. Most projects express value based on return on investment (ROI) where values are combined into a percentage of average return over time. ROI measures can be

subjective. On the one hand, it is difficult to separate the impact of a particular project as the primary cause of a specific effect due to the overlap with other projects and initiatives that are occurring simultaneously. On the other hand, PM brings, not only tangible benefits, but also intangible benefits that are hard to quantify in terms of long-term impact.

University-industry R&D collaborations are characterized by its heterogeneous partners that have different individual goals and different perspectives of the value of PM. Therefore, the initial 'Value checklist' of university-industry R&D collaborations was, firstly, based mainly on the work of Zhai *et al.* (2009) "Value framework of PM in mega-projects" and adapted to the specific case of collaborative university-industry R&D, as well as on participant observation and document analysis of the case study.

This research highlights the stakeholder-centric approach (Eskerod, 2017). The 'Value Checklist' uses the value perceived by stakeholders to determine the PM value. Thus, there are six dimensions representing the key stakeholders: university-industry consortium; university; industry; R&D external entities; funding entity; and society. For each stakeholder, categories and values were identified. Although, a temporary organization is established when two organizations start a collaboration – the consortium, they are heterogeneous partners and for that reason, the dimensions university and industry were also created to guarantee that both perspectives are incorporated in the analysis. Public funding has an important role in promoting the collaboration between universities and firms. Since many university-industry collaborations are subsidized by them, funding entities are also considered a key stakeholder. Table I presents the 'Value Checklist' that include the stakeholder values

identified by participant observation and document analysis divided into categories and the major sources of literature underpinning each value.

Table I. Value Checklist

Stakeholder	Category	Value	Research method	Sources
University-Industry Consortium	Project Performance	Assure cost, duration & quality	Document analysis	Mir and Pinnington (2014), Zhai *et al*. (2009), PMI (2017), Thomas and Mullaly (2007)
		Achieve expected benefits	Document analysis	Badewi (2016) Thomas and Mullaly (2007)
	Professional Development	Provide career opportunities	Observation	Zhai *et al*. (2009)
		Enhance motivation and training	Observation	Zhai *et al*. (2009)
	Long-term Partnership	Greater partnership satisfaction	Document analysis	Zhai *et al*. (2009) Chin *et al*. (2011)
		Increase future collaborations	Document analysis	Zhai *et al*. (2009)
	Relationships	Improve UI communication	Observation	Zhai *et al*. (2009), PMI (2017), Chin *et al*. (2011), Mengel *et al*. (2009)
		Improve stakeholders' satisfaction	Document analysis	Zhai *et al*. (2009)
		Strong partnership loyalty	Observation	Zhai *et al*. (2009), Chin *et al*. (2011)

Stakeholder	Category	Value	Research method	Sources
		Attract new partners	-	Zhai *et al*. (2009)
	Competencies	Enhance PM capabilities	Observation	Zhai *et al*. (2009), Barnes *et al*. (2002), Mengel *et al*. (2009)
		Enhance knowledge management	Document analysis	Zhai *et al*. (2009), Seppo and Lilles (2012)
		Improve technology innovation	-	Perkmann *et al*. (2011a), Zhai *et al*. (2009)
		Improve collaboration skills	Observation	Zhai *et al*. (2009), Seppo and Lilles (2012)
		Organizational transformation	Document analysis	Perkmann *et al*., (2011a), Zhai *et al*., (2009), Fernandes *et al*. (2017)
	Culture	Enhance collaboration culture	Observation	Zhai *et al*. (2009), Mengel *et al*. (2009)
University	Academic Value	Achieve academic objectives	Document analysis	Zhai *et al*. (2009)
		Close proximity to business	Observation	Ankrah and Al-Tabbaa (2015)
		Academic recognition	Observation	Ankrah and Al-Tabbaa (2015)

Stakeholder	Category	Value	Research method	Sources
		Attract new researchers and students	Observation	Ankrah and Al-Tabbaa (2015), Chin *et al*. (2011)
	Academic Capabilities	Enhance scientific impact	Document analysis	Seppo and Lilles (2012)
		Improve PM knowledge	Observation	Zhai *et al*. (2009), Scandura (2016), Becker and Dietz (2004)
Industry	Industry Value	Technological output	Document analysis	Perkmann *et al*. (2011a), Scandura (2016), Seppo and Lilles (2012)
		Identify prospective employees	Observation	Scandura (2016), Seppo and Lilles (2012)
		Achieve commercial goals	Document analysis	Scandura (2016), Seppo and Lilles (2012)
		Increase business recognition	-	Ankrah and Al-Tabbaa (2015)
	Industry Capabilities	Improve PM knowledge	Observation	Zhai *et al*. (2009), Scandura (2016), Becker and Dietz, (2004)
		Increase personnel qualifications	Document analysis	Zhai *et al*. (2009)

Stakeholder	Category	Value	Research method	Sources
		Increase capacity for innovation	-	Scandura (2016), Becker and Dietz (2004)
	Commercialization	Acceleration of commercialization of new technologies	Observation	Ankrah and Al-Tabbaa (2015), Zhai *et al*. (2009)
Funding Entity	Funding Entity Value	Better collaboration experiences	Observation	Zhai *et al*. (2009)
		Achieve program/ project results	Document analysis	Zhai *et al*. (2009), Scandura (2016)
R&D External Entities	R&D External Entities Value	Improve management capabilities	Observation	Zhai *et al*. (2009)
		Long-term strategic partnership	Document analysis	Zhai *et al*. (2009)
Society	Society Value	Economic and social development	-	Zhai *et al*. (2009)
		Foster PM expertise in UI collaborations	Observation	Zhai *et al*. (2009)
		Promote R&D of excellence	-	Mengel *et al*. (2009)
		Improve technical standards	-	Zhai *et al*. (2009)

Consortium values

Good PM practice will provide value at both an economic and organizational level. On the economic side, PM will improve values which can be measured through the "iron triangle" (Zhai *et al*., 2009). PM practices will improve 'project performance' (Mir and Pinnington, 2014), i.e. 'save cost, 'shorten time' and 'improve quality', as well as 'achieve expected benefits' (Badewi, 2016). On the organizational level, PM can improve consortium 'professional development', 'long term partnership', 'Relationships', 'Competencies' and 'Culture' (Zhai *et al*., 2009). Improving 'Competencies' for example can impact on enhancing PM capabilities including knowledge management and innovation and collaboration skills (Zhai *et al*., 2009). According to Barnes *et al*. (2002), university-industry consortiums with 'enhance(d) PM capability' will have clearer objectives, better progress monitoring, effective communication and high-quality project managers, which are essential to the success of this type of collaborations. In addition, the increase in PM investments demonstrates the collaboration's capability of handling larger projects (Zhai *et al*., 2009). Enhancing knowledge management for example might be achieved through good PM practices such as project reports and lessons learned, and the use of a software to support PM (Zhai *et al*., 2009). Moreover, Seppo and Lilles (2012) refer to the publication of joint articles as a good indicator of knowledge diffusion. Improved innovation is related to the rise of new ideas due to the collaboration work (Zhai *et al*., 2009). This can take the form of new products and improved processes, as well as "solution concepts" that are frameworks proposing solutions to a specific problem without resorting to technical specificities, according to Perkmann *et al*. (2011).

The number of previous partnerships and the staff involved in the activities of the collaboration indicates the experience gained in university-industry collaborations (Seppo and Lilles, 2012). Therefore, all the people involved on this type of project will most likely 'improve collaboration skills'. According to Zhai *et al*. (2009), as the organization gains experience from PM practice and becomes more mature, its organization structure develops to a more project-centred organization with PM as a core competency. The management challenges that university-industry collaboration faces due to different short, medium and long-term objectives of each partner suggests that, in order to be productive, the partnership needs to be adequately structured and managed (Perkmann *et al*., 2011). One way of mitigating this problem is through the creation of Project Management Office structures (Aubry and Hobbs, 2011; Fernandes *et al*., 2018) in order to smooth organizational transformation.

Relationships are enhanced through the improvement of university-industry communication. The PMBOK states that effective communication creates "a bridge between diverse stakeholders who may have different cultural and organizational backgrounds, different levels of expertise, and different perspectives and interests" (PMI, 2017, p.287). In addition, "communication should be carried out with clarity, completeness and in a concise manner in order to maintain and enhance the relationship, trust and confidence between the partners" (Chin *et al*., 2011, p. 912). Thus, a better communication will lead to improve stakeholders' satisfaction, stronger partnership loyalty and the ability to attract new partners.

According to Zhai *et al*. (2009), PM has also a positive effect on forming a cohesive and favourable organizational culture. This was also confirmed by Mengel *et al*. (2009). According to the author, "communicate effectively across internal and

external boundaries based on a joint PM approach and on sufficiently shared values have proven to be important components" (Mengel *et al*., 2009, p.39).

In terms of professional development, the success of the collaboration will create new career opportunities for the people involved in the collaboration, not only in terms of career advancement for people already in the industry but also the opportunity for students to enter the job market. In addition, it will also motivate the staff and improve training that can be indicated by PM certification. If the overall result of the collaboration is satisfactory for both partners, then they are more likely to collaborate in the future, building, therefore, a long-term cooperative partnership. Although most of the value categories for the university are the same as the industry, its PM values are different. This is because they are two entities with different focus on objectives (Fontana *et al*., 2006).

University values

A project will be of value if it is perceived as successful. In the case of the university, the success is dependent on the achievement of its academic objectives such as the publication of research results in academic journals and to run projects for research students leading to postgraduate degree qualifications (Barnes *et al*., 2002). Moreover, the number of articles published increases its recognition in the academic community. One of the main reasons to collaborate with the industry is the proximity to the business environment (Ankrah and Al-Tabbaa, 2015). In the case study, the employment of research assistants by the industry demonstrates that the project was valuable for the university. PM will allow the collaboration's partners to improve the University's

capabilities indicated by the scientific impact or in other words, the number of times an author's publication is cited (Seppo and Lilles, 2012) and by the improvement of PM knowledge. The number of researchers with experience in PM and the number of researchers with certification in the field can also indicate values of PM.

Industry values

The industry stakeholder will realize the value of the project not only if it can produce technological outputs but also, if it achieves commercial goals and employs high qualified personnel from the university (Scandura, 2016; Seppo and Lilles, 2012) and increases business recognition (Ankrah and Al-Tabbaa, 2015). Technological output may be translated into new products and/or process improvements (Seppo and Lilles, 2012), and the number of patents granted (Perkmann *et al*., 2011). In addition, the publication of joint articles and the increase in PM investment can increase business recognition.

Through the network of relationships arising from the collaboration, university-industry projects provide the opportunity for enhanced organizational learning (Becker and Dietz, 2004; Scandura, 2016). Universities are also a source of new techniques and instruments that enable the industry to develop new technology (Perkmann *et al*., 2011). According to Zhai *et al*. (2009), PM makes it possible for the organization to take full advantage of its competencies to help the other project participants with management and technical problems. Adapting to the R&D collaboration context, the university will also help to improve industry's capabilities. Thus, the organization will improve its PM knowledge and increase its capacity for innovation. Another value is the firm's

education of its own employees. In this case study, the proportion of industry collaborators with a high level of postgraduate qualification (master or Ph.D.) indicates increased personnel qualifications. As mentioned before, efficiency is one of the motives for the industry to collaborate with universities. Thus, university-industry collaborations enable the rapid commercialization of new technologies and therefore, shortens the time to market (Ankrah and Al-Tabbaa, 2015).

R&D external entities, funding entity and society values

R&D external entities, such as sub-contractors, perceive the value of PM through the improvement of their technical and management capabilities and by the development of long-term strategic partnerships (Zhai *et al*., 2009). The funding entities perceive the value of PM through their experiences in the collaboration and by the achievement of projects goals. PM will allow all stakeholders to communicate more effectively and cooperate with each other in order to optimize project objectives.

According to Scandura (2016, p. 1920), universities are "*an integral part of the supply chain to firms to support business growth and economic propensity*". In addition, Becker and Dietz (2004) state that firms invest more in innovation when they are engaged in R&D cooperation. Therefore, successful university-industry R&D collaborations will promote economic and social development such as the creation of new jobs (number of people hired for the collaboration) and a greater movement of people between universities and industry (number of researchers and industry collaborators involved). In addition to the wealth creation provided by the R&D collaboration, the information flows and spill overs between the two economic agents

will also improve the performance of the national systems of innovation and R&D excellence (Barnes *et al*., 2002; López, 2008).

Being part of a university-industry collaboration will improve the capabilities of its collaborators to foster a large number of talents in PM. In terms of technical standards and management mechanisms, the practices implemented that lead to the positive experience of the collaboration will be analysed and replicated by other collaborations, improving, therefore, PM in further university-industry collaborations. Published articles regarding best practices in this context help to improve the knowledge as well as the awareness of PM in university-industry collaboration.

4.2 Value framework for project management

Twenty-seven interviews were conducted with key stakeholders to establish a Value Framework or enhanced set of values for a particular collaboration project. The purpose of the interviews were to validate and prioritize the PM values identified in the 'Value Checklist' and also identify new values in the context of the particular case study. A Value Framework was developed that included:

- Values from the literature survey, participant observation and document analysis that were validated by survey participants.
- New values identified by survey participants during the interviews and discussions.
- Values that could be eliminated from the framework because interviewees placed a low emphasis on them and

- Rephrasing or better definition of some values based on the participant requirements.

The participant organizations were University of Minho with 55% of participants, Bosch with 37%, and the R&D external entities subcontracted with 8%. In terms of their role in the collaboration, most interviewees were from the Project Management Office (37%), followed by project managers (26%), team members (26%), program managers (7%), and directors (4%). In terms of experience, the majority of respondents had less than 6 years of experience in both PM (16 interviewees) and university-industry collaborations (17 interviewees). Most of the interviewees were between 30 and 40 years old (41%) followed by participants between 40 to 50 years old (33%), 25 to 30 years old (19%), and 7% are more than 50 years old. Most participants were male (70%).

Through the question "*what are the values of PM in the university-industry collaboration projects?"* plus supplementary questions, where interviewees were directly asked about the PM values identified in the 'Value Checklist' (Table I), in order to have a more detailed answer about the key values, it was possible to compare the categories and values of the initial 'Value Checklist' with the interviewees' responses. Table II presents, for each value, the percentage of interviewees that agreed with and confirmed the value, i.e. the correspondent percentage of agreed responses from the total of 27 interviews. This appears under the '% Agreement' column. New values that emerged through the interviews are also presented under the 'Status' column as 'added'. Table II has been sorted according to the '%Agreement' with each value.

Since there were no PM values with no mentions positively or negatively by interviewees, the decision to confirm or remove a PM value was based on the analysis of the percentage of respondents who mentioned this PM value positively, relative to the total number of respondents who mentioned it positively or negatively. This is represented by '%Positive M*entions*' column in Table II. Thus, values were automatically confirmed if '%Positive M*entions*' was higher than 50%. In other words, at least half of the interviewees who mentioned it agreed with the value. When '%Positive M*entions*' is lower than 50%, then interviewees' responses to the particular value were analysed in more detail. This analysis indicated if the value would be accepted or removed, namely taking into consideration researchers' experience in this particular context of collaborative university-industry R&D. The interviews and respondents feedback also allowed values to be rephrased to enhance its accuracy. On the other hand, new values emerged during the interviews. Most of the values in the different six dimensions were automatically confirmed.

Table II. Interviewee responses to the PM values

Stakeholder	**Category**	**Value**	**% Agreement**	**%Positive Mentions**	**Status**
Consortium	Relationships	Improve UI communication	85%	92%	Confirmed
University	Academic Value	Achieve academic objectives	74%	100%	Confirmed
Industry	Industry Value	Achieve commercial goals	74%	95%	Confirmed
Consortium	Project performance	Assure cost, duration & quality	70%	91%	Confirmed
Consortium	Long-term Partnership	Increase future collaborations	70%	95%	Confirmed
Consortium	Culture	Enhance collaboration culture	70%	91%	Confirmed

Stakeholder	Category	Value	% Agreement	%Positive Mentions	Status
University	Academic Capabilities	Improve PM knowledge	68%	100%	Confirmed
Consortium	Competencies	Organizational transformation	59%	94%	Confirmed
University	Academic Value	Academic recognition	59%	73%	Confirmed
Industry	Industry Capabilities	Improve PM knowledge	59%	80%	Confirmed
Consortium	Competencies	Improve collaboration skills	56%	100%	Confirmed
Funding Entity	Funding Entity Value	Better collaboration experiences	56%	100%	Confirmed
Funding Entity	Funding Entity Value	Achieve program/ project results	48%	100%	Confirmed
External Entities	R&D External Entities Value	Improve management capabilities	48%	100%	Confirmed
External Entities	R&D External Entities Value	Long-term strategic partnership	48%	100%	Confirmed
Consortium	Relationships	Improve stakeholders' satisfaction	44%	92%	Confirmed
Industry	Commercialization	Accelerate commercialization	41%	58%	Rephrased
University	Academic Capabilities	Enhance scientific impact	33%	82%	Confirmed
Consortium	Competencies	Enhance PM capabilities	30%	89%	Confirmed
University	Academic Value	Close proximity to business	30%	80%	Confirmed
Society	Society Value	Improve technical standards	30%	100%	Confirmed
Industry	Industry Value	Increase business recognition	26%	41%	Confirmed
University	Academic Value	Attract new researchers and students	22%	46%	Confirmed
Consortium	Relationships	Attract new partners	15%	57%	Confirmed
Consortium	Competencies	Enhance knowledge management	15%	100%	Confirmed
Consortium	Competencies	Improve innovation skills	15%	44%	Confirmed

Stakeholder	Category	Value	% Agreement	%Positive Mentions	Status
Industry	Industry Value	Technological output	11%	75%	Confirmed
Industry	Industry Capabilities	Increase personnel qualifications	11%	60%	Confirmed
Industry	Industry Capabilities	Increase capacity for innovation	11%	30%	Removed
Funding Entity	Funding Entity Value	Improve communication	11%	100%	Added
Consortium	Future Funding	Secure Future Funding	7%	100%	Added
Consortium	Professional Development	Enhance motivation and training	7%	67%	Confirmed
Consortium	Relationships	Strong partnership loyalty	7%	100%	Confirmed
Industry	Industry Value	Identify prospective employees	7%	18%	Confirmed
Society	Society Value	Economic and social development	7%	100%	Confirmed
Consortium	Project performance	Achieve expected benefits	4%	100%	Confirmed
Consortium	Professional Development	Provide career opportunities	4%	50%	Confirmed
Consortium	Relationships	Alignment of stakeholders	4%	100%	Added
University	Academic Capabilities	New laboratory equipment	4%	100%	Added
Society	Society Value	Foster PM expertise in UI collaborations	4%	100%	Confirmed
Society	Society Value	Promote R&D of excellence	4%	100%	Confirmed

5. Discussion

Responding to the call of Thomas and Mullaly (2007) this research has examined the values of PM at a sub-organization or project level, and in the particular context of a large university-industry R&D project. Several scholars have argued that the perceived traditional values of PM may not be applicable to all R&D projects (Benner and Tushman, 2003; Du *et al.*, 2014; Shenhar and Dvir, 1996). This research has demonstrated that PM has the potential to manage more than ROI and can also be impactful on a wide variety of other values defined by key stakeholders. These additional values have been grouped earlier for the specific case of a university-industry collaboration under the key stakeholders: consortium, university, industry, external entities, funding entity and society. Our discussion now focusses on each of these stakeholders to provide further details of research results and linkage back to established research previously reported by other authors.

5.1 Refining the value framework for project management

Consortium values

Regarding the overall consortium dimension all interviewees in this research unanimously confirmed all of the values proposed in the 'Value Checklist', with the single exception of 'improve innovation skills'. However, since most experienced interviewees answered positively in opposition to the responses of those less experience, the value was maintained in the proposed Value Framework. Two new

values emerged through the interviews. According to one interviewee, “PM ends up balancing stakeholder’s forces so that the main goal is never lost” (interviewee no.5) and so ‘alignment of stakeholders’ was included in the framework. This closely reflects the findings of van der Hoorn and Whitty (2017) who found that alignment seeking among stakeholders was a key activity in PM. In addition, the level of stakeholder’s engagement is well-recognized in literature as critical for project success, namely in R&D projects (Elias *et al.*, 2002).

Another respondent mentioned that PM also helps with securing further funds (interviewee no.10). In this regard, the value ‘secure future funding’ was also added to the framework. This value may be particularly important in university-industry projects that commonly involve a public funding body (Brocke and Lippe, 2015).

The most highlighted PM values were: ‘improve university-industry communication’, ‘assure cost, duration & quality’, ‘increase future collaborations’ and ‘enhance collaboration culture’. ‘Improve university-industry communication’ is exemplified by interviewee no.9 who stated that “one of the main functions of PM is to streamline communication between all parties; and it was very important to have a PgPMO coordinating the interaction between the university and Bosch; they were able to speed up the work from both parties, and strengthen the partnership”. This reflects the work of Chin *et al.* (2011) who highlighted the need for a constant transparent communication among university-industry key stakeholders.

Interviewee no.7 emphasized the value: ‘assure cost, duration & quality’ of the project when he stated: “PM is aimed at managing efficiency [and] in Bosch and UMinho’s projects we achieved the best possible results within the limited resources we

had and within the established deadline." As discussed in literature, there is a link between PM performance (project cost, duration and quality achievement) and project success (e.g., Badewi, 2016; Mir and Pinnington, 2014).

The value 'increase future collaborations' was emphasized by interviewee no.13 when he stated that: "there was always a focus on making things work better and better [and] the PgPMO helped creating trust within Bosch in the partnership, and, when there is trust, the longevity of the partnership is greater". This is also highlighted by Zhai *et al.* (2009) who discuss PM capability that helps to identify the client's needs rapidly and accurately. Therefore, PM increases client satisfaction and loyalty leading to a long-term cooperative relationship. In the case of university-industry R&D collaborations, it leads to new future collaborations and consequently to sustainable university-industry partnerships.

According to interviewee no.27 the value 'enhance collaboration culture' within the PgPMO "enabled a common language between all parties, and a set of rules that facilitated the collaboration between academic and industry members". This reflects the findings of Mengel et al. (2009) who states that the PMO serves as a single source of information, linking the executive vision and the operational work, facilitating a constructive collaboration.

University values

For the university dimension, only the value of increasing the capacity to 'attract new researchers and students' was not automatically confirmed during interviews. However, after analysing interviewee responses it was decided to include it in the value

framework as the $\%mentions$ was very close to 50%. This value also reflects findings from Ankrah and Al-Tabbaa (2015) who found that researchers and students see university-industry projects as opportunities to training and future employment. One interviewee highlighted the fact that universities benefit from the equipment bought for the collaboration project since it will be available to the university's researchers and students for many years. According to interviewee no.11, "It is a benefit of the collaboration, but also associated with PM because it is the one [entity] that effectively has to allocate those resources". This echoes the work of De Fuentes and Dutrénit (2012) who emphasized acquiring equipment as one of the seven most important researchers' benefits of engaging in R&D collaborations with industry. In this respect, the value 'new laboratory equipment' is included in the framework.

Most values in this category received more than 70% in $\%mentions$, with two values 'achieve academic objectives' and 'improve PM knowledge' reaching 100%. According to interviewee no.24, "PM facilitates the achievement of universities objectives because it allows the university to follow the entire development process of the project and therefore, ensure the achievement of their [own] goals". PM also assures that the objectives achieved are the ones that have led the university to collaborate in the first place according to interviewee no. 20 and that this also enhances values such as of 'product or process developments', and 'academic recognition' (interviewee no.4). These values have also been argued by Zhai *et al.* (2009), who also states that excellent PM also raises the possibility to smoothly realize the expected overall value of a project.

Industry values

Regarding the industry dimension, the three PM values 'identify prospective employees', 'increase business recognition' and 'increase capacity for innovation' were not confirmed directly through the analysis of $\%mentions$. One reason why some interviewees did not agree with 'identify prospective employees' was that they see it as a primary benefit of the collaboration (as seen by Scandura (2016) or Seppo and Lilles (2012)) and indirectly, as a benefit of to be emphasized by PM. However, good PM can be used to improve a better management of talents, resulting in offering employability-strengthening job opportunities (Bredin and Söderlund, 2013); therefore, it was maintained in the Value Framework.

In terms of the PM value 'increase business recognition', some interviewees cited that Bosch is already a well-known enterprise and therefore, this collaboration does not need to increase its recognition. However, one of the benefits Bosch itself expects to obtain from this collaboration is the "consolidation of Bosch reputation among customers and within the Bosch Group itself" (Fernandes *et al*., 2017, p. 1078). One can infer from this the reputation and corporate responsibility among local communities in Portugal who for example also provide an engaged and loyal workforce. Interestingly, most interviewees who did not consider this a PM value five were from the University and only three were from Bosch. Although most interviewees did not agree the PM value was confirmed assuming that all organizations will require continuous maintenance of their corporate and community recognition.

The PM value 'increase the capacity for innovation' was removed, because several interviewees argued that PM has a negative impact on creativity and therefore

on innovation. This is aligned with the research results of some authors, for example, Benner and Tushman (2003) who argued that while process management activities are beneficial for organizations in stable contexts, they are fundamentally inconsistent with innovation and change. A starting point for innovation is the creativity by individuals and teams (Amabeli *et al.*, 1996), and the PM strict deadlines the division of labour and communication procedures constrains plurality and creativity (König *et al.*, 2013).

During the interview response analysis, the researchers realized, that in the specific case of R&D projects, the aim is not the commercialization of technologies but instead, the development of technologies and prototypes. Industries commonly do not commercialize the developed technologies but integrate them into existing products and processes. Thus, the PM value 'acceleration of commercialization of new technologies' was rephrased to become more generic i.e. 'accelerate commercialization'. This was the most highlighted PM value for the industry stakeholder, emphasizing the impact of PM practices in the realization of benefits, which goes beyond the project outputs (Badewi, 2016).

R&D external entities, funding entity and society values

Regarding the funding entity dimension, both PM values were confirmed. Almost half of respondents agreed with the PM values, wherein all interviewees that mentioned the PM values agreed with them. Some interviewees mentioned that one of the main benefits of PM in these collaborations is the communication with the funding entity. In the case study, the settled Project Management Office is considered the interlocutor, both in the process of preparing the application and in the monitoring of the project over

time (interviewee no.19, interviewee no.24). As stated by interviewee no.24, “PgPMO played a very important role in facilitating the dialogue between entities that have a different language of their own and which also have different objectives”. Thus, the value ‘improve communication’ was added to the Value Framework. This echoes the research of Barnes *et al.* (2006) who argue that good communication is critical for university-industry R&D collaborations success; and a PgPMO play an important role in the communication process among stakeholders, namely with the funding entity (Fernandes *et al.*, 2018).

The most highlighted PM value for the funding entity stakeholder was ‘better collaboration experience’, as exemplified by interviewee no.7 who stated “all the project information is better organized, facilitating the project monitoring and control by ANI [name of the funding entity], which has already informally acknowledged the excellent collaboration experience within Bosch and UMinho consortium.”

Regarding the R&D external entities and the society dimensions, all PM values identified in the initial ‘Value Checklist’ were confirmed and no new values emerged. Moreover, none of the most highlighted PM values were related to the R&D external entities or society stakeholders. A summary of the PM Value Framework resultant from the interview analysis is presented in Figure 1.

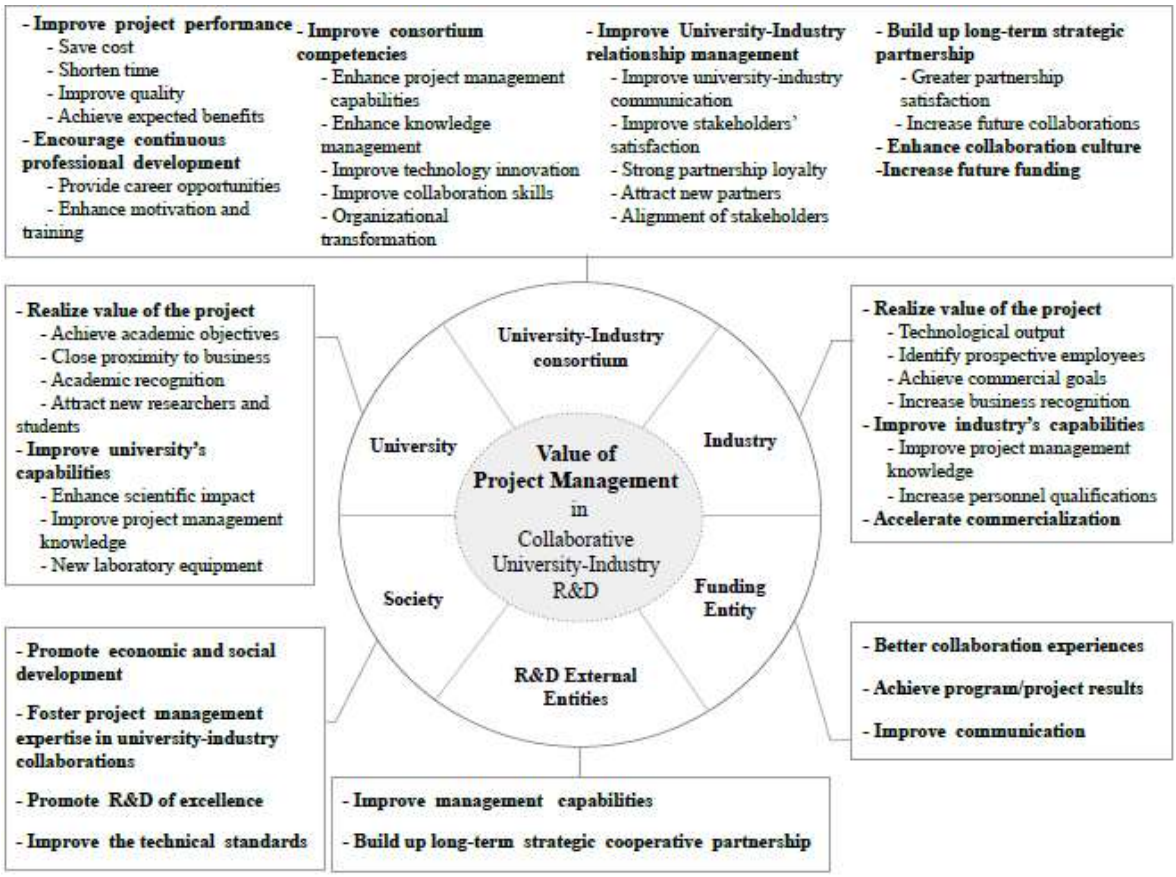

Figure 1. Value Framework of PM in Collaborative University-Industry R&D.

5.2 Strengths and limitations of the framework

An important strength of the PM Value Framework is that it helps manage the values brought by a university-industry collaborative project while emphasizing the importance of a stakeholder approach (Freeman, 1984; Turner and Zolin, 2012). Other strengths include emphasizing the importance of a contingency approach (Hanisch and Wald, 2012) when pursuing the multiple stakeholder values in a project and also highlighting the importance of assessing the relevance of values for a particular project or case study. All different project types would benefit from a contingency theory perspective. However, the study developed by Hanisch and Wald (2012) shows that R&D projects

are the most dominant project type in project contingency research, among IT and construction projects. In this regard, this research highlights the stakeholder-centric approach (Eskerod, 2017), drawing from concepts like *shadow of the past*, *shadow of the future, and shadows of the context* detailed in Eskerod and Larsen (2018), i.e., a project should not be seen as a single unit of analysis isolated from both temporal and environmental contexts.

Like any framework, the PM Value Framework portrays a partial and incomplete view of reality and should therefore be used cautiously by university and industry partners who can modify and adapt it to their own specific circumstances. In this regard, the researchers note some limitations. Firstly, the results are induced from one case and might thus be contingent upon its special context, and the reasoning could be influenced by random factors. This may cause deviations as to the final conclusions. In this regard, future studies can further induce from other case studies and then cross-check their conclusions. Secondly, PM is highly contingent on the organizational context (Hobbs and Besner, 2016); therefore, further applications of the framework through more case studies will be valuable for observing namely the weight of specific PM values by different organizations and examining the impact of factors such as industrial sector, size, strategy, geographic location, place on different PM values.

5.3 Method for applying the value framework

This discussion concludes by presenting a simple method that can be applied for defining and applying the Value Framework. The method was created during this study as a decision support tool on how PM professionals could define, deploy and monitor

core PM values in similar projects. The method involves four steps presented in Figure 2.

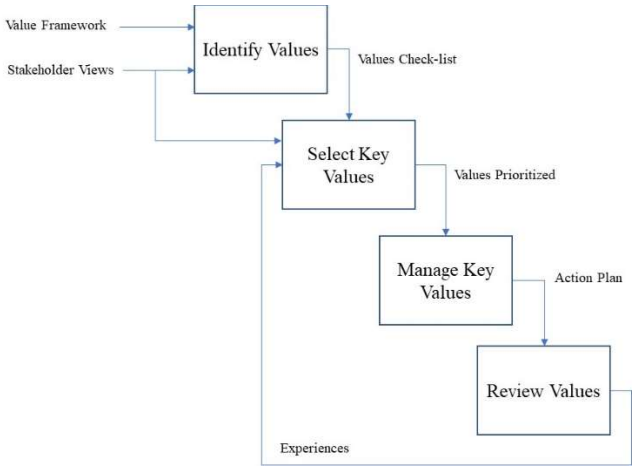

Figure 2. Method for applying the value framework.

The first step involves identifying values, therefore is necessary to acknowledge stakeholders involved in the collaborative university-industry R&D project of all the values identified in the PM Value Framework that might be potential values to identify for their particular project, and add their stakeholders' views in order to produce a 'Value Checklist'. The next stage involved selecting the top values requiring periodic management by the PM team. A simple tool for prioritizing the most 'important' values identified by stakeholders might be used, by determining the ration of their 'importance' and 'progress'. A simple traffic lights system might also be used to illustrate which values need attention, and a assigning of those 'responsible' from members of the core PM team for oversight and management of each value during the lifetime of the collaboration. The final step in the method involved a periodic review (every 12 months) of the Values being managed including the development of action

plans to assure management of the most important values and communication to various stakeholders about how values were being achieved.

5. Conclusions

The research reported in this paper has both theoretical and practical contributions. The paper builds knowledge in the area of PM value for the particular context of R&D collaboration projects, which has been put into question by several scholars (Benner and Tushman, 2003; Du *et al.*, 2014; Shenhar and Dvir, 1996). A PM Value Framework was developed around a theoretical foundation elucidated in peer-reviewed research papers and then empirically explored in a major case study that confirmed many of its features (Shapira, 2011). The theoretical foundation was developed around a literature review, having as a main theoretical framework the work of Zhai *et al*. (2009). Qualitative research consisted of 27 semi-structured interviews, with different key stakeholders from the large case study were used to refine the framework.

The PM Value Framework consists of six value dimensions represented by the key stakeholders: university-industry consortium, university, industry, external entities, funding entity and society. For each stakeholder, a set of key PM values were identified, accounting to a total of 41 tangible and intangible values. Although, different values were defined for each stakeholder, they are interrelated. For example, PM improves the relationship between stakeholders, which consequently may lead to building long-term partnerships.

The framework incorporates initial values listed in the 'Value Checklist' and informed from existing research on the theoretical understanding of PM values. This

checklist can be suitably modified for a particular case study or project to reflect suggestions from a particular domain or project. Analysis of detailed stakeholder requirements, namely through interviews, from a particular case study serves to identify new values, add or remove some values and rephrase others. In addition, the interviews make it possible to raise awareness, at least for the participants, of the different dimensions of PM value. Thus, the results of this research also have practical contributions, bringing a clearer vision of the value of PM through a framework that took a stakeholders perspective and that can be used as a blueprint by practitioners who aim to demonstrate the PM value in R&D collaborating contexts. Not only does PM serve as a tool to manage the expectations and needs of the different key stakeholders involved, but also as a tool to manage many outputs and knowledge generated in R&D initiatives. Moreover, this paper exemplifies how professionals can make use of the PM Value Framework in any collaborative project, using a simple four steps method.

The research was deductive in nature, drawing on theory from a wide number of sources. This theory was explored in a major case study through the collection of empirical data. As any research based on only one case study limits the generalizability of its findings therefore the framework is presented to support decisions on creating specific frameworks in other similar projects. Additionally, R&D collaborations among organizations take many forms, such as collaborations among only industry members or among only universities and knowledge institutes. These cases, although similar, still have fundamental differences that also deserve research attention.

Acknowledgement

This work was supported by the FCT - Fundação para a Ciência e a Tecnologia; under Grant SFRH/BPD/111033/2015. The authors gratefully acknowledge the contributions of the 27 participants in the interview phase of the research. Without their support this work would not have been possible.

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