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A Stakeholders' Perspective on Risk Management for Collaborative University-Industry R&D Programs

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Abstract

University-industry collaborative programs provide special challenges in understanding and expressing the value of risk management (RM) in delivering program and project benefits. This paper presents a methodology for managing the risks in major university-industry R&D programs within a stakeholders' perspective. An ethnographic study was conducted on a multi-million euro university-industry collaboration initiative. The RM methodology identifies, for each of the key stakeholders, the RM activities in the program, which are largely derived from research literature. Empirical research then prioritizes and selects key RM activities. The research is informed using a case study involving one university and one large industrial partner. Empirical research was conducted by researchers who observed, for five years, at close quarters, the challenges of managing risk in major collaborative programs. The developed RM methodology takes a stakeholders' perspective, by identifying, for each of the key three stakeholders - Program Manager, Project Manager and Program and Project Management Officer, the respective RM activities.

Keywords: Risk Management; Stakeholders' Perspective; University-Industry R&D Collaborations.

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1. Introduction

Programs and projects are a mechanism to bring benefits and value to organizations. A program is a set of projects whose objectives are related and aim at achieving a set of major benefits that are more than just the sum of the benefits of the different projects [1]. In the modern business environment, corporate leaders need to be capable of managing with shorter deadlines, smaller budgets, fewer resources and instantly changing technology [2]. Programs and projects are continually under pressure, as a result of the globalization's challenges and its innovative character [3]. In this context, the environmental changes can present different risks and organizations should equip themselves with comprehensive knowledge to promptly deal with the project risks resulting from this dynamic environment. Therefore, within project management, a key area emerges - Risk Management (RM), which intends to minimize the probability and impact of project threats and to capture the opportunities that may arise during a project lifecycle [4].

In order to make the best use of knowledge, several university-industry Research and Development (R&D) collaborations have been established. With the expansion of these partnerships and their value in promoting the development of strategic national and especially regional economies, it is essential to develop new methods to respond to the specific difficulties that arise from a partnership of this nature, since the know-how in this area is limited [5], [6]. One of the greatest challenges of university-industry partnerships is to manage the several risks that collaborations of this kind face during their lifecycle, namely during the process of continuously identifying new risks and qualifying their risk level for both partners. The program and project managers assume an important role in the analysis of the expectations and impact of programs and projects on the organization's partners. They may be able to develop appropriate management strategies in order to achieve program and project success. In the context of RM, stakeholders can follow specific guidelines in order to reduce the risk impact associated with this type of R&D collaborations and, consequently, to increase the success of programs and projects.

This paper aims to present a RM methodology specially developed for collaborative university-industry programs within a stakeholders' perspective, by presenting the results of an ethnographic study on a large-scale collaborative university-industry R&D program. This program covers several projects, between Bosch in Portugal and the University of Minho, and targets critical R&D for advanced multimedia systems for the automobile industry. The main purpose of this paper is to give detailed guidance on how key stakeholders can manage risks in a collaborative R&D program.

The following section presents the relevant literature background for the paper. Then the research methodology used is explained, which is followed by the research findings on the key RM activities performed by different key stakeholders. Finally, the last section presents some discussions and conclusions, including limitations and further work.

2. Background

2.1. University-Industry Collaborations

In an atmosphere of globalization, intensifying competitiveness and increasing R&D costs, collaboration has become an important way to support technological growth. University-industry R&D collaborations have been growing over time, keeping up with the increasing globalization of the economy and the rising complexities of industrial processes [7]. These are fostered by the government, as a vehicle to enhance national competitiveness and enhance wealth creation. While universities are mainly motivated to generate new insights and to educate, private companies are prompted by the gathering of valuable knowledge that can be leveraged to gain competitive advantage. In addition, universities are becoming more and more proactive in their collaborations with industry, seeking to generate valuable Intellectual Property to promote technology exchange [8].

Accordingly, more and more interactions between university and industry are now being actively managed, which is leading to more formal, contractual arrangements based on coded norms and standards [8]. There is a variety of reasons that make organizations want to get involved in research collaborations with universities. Perkmann, Neely and Walsh [9] identified four principal reasons: 1) much government funding for R&D programs requires the participation of universities; 2) companies need to get access to new research and critical competencies that enable them to reach cutting-edge technology and boost it further; 3) companies seek to improve their problem resolution capabilities and academic researchers are contracted to solve difficulties; and 4) these collaborations result in a number

of other benefits, such as capturing talented employees and enhancing the company's reputation. However, collaborations between different organizations are often difficult to manage because of the cultural distinctions between academy and industry, which entails specific challenges.

Collaborative university-industry R&D initiatives are generally sponsored and labeled as projects by the funding bodies but are frequently organized as programs by partners. A program is a group of related projects designed to bring about a number of significant benefits that are more than just the ones resulting from the sum of the projects which they consist of [1]. A collaborative university-industry R&D program is defined here as a temporary organization with a project-based collaborative working environment, inside a particular context, with diversified partners, collective responsibilities and, in the majority of cases, competitive financial state support [10].

With a growing occurrence of university–industry collaborative R&D projects and programs and associated failure reports, considerable research has emerged in the identification of management "success" factors. A review of published research concerning university-industry collaboration disclosed a number of key "success" factors, and risk analysis and management is among them [6].

2.2. Risk Management

The Project Management Institute [2] defines risk as "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives". All projects are risky, as they are unique enterprises, with different degrees of complexity, which aim to provide benefits. They do so in a context of restrictions and assumptions, while at the same time responding to stakeholders' expectations that can be contradictory and changeable. Organizations should choose to assume project risk in a managed and deliberate way in order to provide value, while balancing risk and reward [2].

The definition of risk involves both uncertain events that may negatively affect the project (threats), and those that can have positive impacts on project objectives (opportunities) [11]. In collaborative university-industry R&D programs, the presence of a high level of uncertainty due to the novelty involved in this type of programs carries high risks, which results in many failures [12]. In this type of programs and projects, it is possible to identify several potential risks, such as an inadequate level of stakeholder involvement in the program; disruptions in information flows and communication between stakeholders; strategic misalignment; lack of project sponsorship and many others [13]. RM has developed quickly over the past decades as part of project management [4]. According to the literature, project RM practices are increasingly required, as they can offer a systematic process for identifying and managing risk, helping to achieve different project aims, improve project monitoring, improve the communication between participants in the project, facilitate the decision-making process and prioritize actions, and ultimately increase the project's chances of success [12], [14]. RM is a continuous process that is directly dependent on the change in the inner and outer environment, which demands ongoing attention for the identification and control of project risks [14]. When unmanaged, risks potentially cause the project or program to diverge from the plan and to fail to achieve the objectives set for the project or program. Consequently, the efficiency of the project's RM is clearly related to the success of the project [3], [15].

In summary, the focus of RM is to develop strategies to mitigate risk negative impacts and increase risk positive impacts on program and project objectives. It addresses risks according to the project's exposure, adding activities and resources to the budget and adapting the project schedule [2].

2.3. Stakeholders' Perspective on Risk Management

In 1984, Freeman [16] defined stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives". Later Savage, Nix, Whitehead, and Blair [17] defined stakeholders as groups or individuals who "have an interest in the actions of an organization and (...) the ability to influence it". After three decades, these definitions are still applicable [18].

Every program or project has stakeholders that are impacted or may impact the program or project in a good or bad way. Certain stakeholders can have a restricted capacity to affect the project work or its revenue; others can have a significant impact on the project and its expected returns. Stakeholder satisfaction should be identified and managed as a project purpose. The key to effective stakeholder involvement is a focus on ongoing communication with all stakeholders, including team members, to understand their requirements and expectancies, to address questions as they occur, to manage conflicting interests, and to promote appropriate stakeholder involvement in project decision-

making and activities [2].

Usually, a simple project involves a high number of stakeholders. Yet, in university-industry R&D collaborations, the number of stakeholders involved is even higher. Therefore, in large scale programs, it is essential to have guidelines for the good performance of stakeholders' functions [2], as there is a need for balancing between having the full picture of stakeholders and getting knocked out by an excess of data [19]. When specifically considering RM, certain guidelines are essential to achieve the success of projects and programs [20]. Consequently, the RM methodology developed and presented in this paper assumes a stakeholders' perspective, identifying the main RM activities for the three main stakeholders involved in the RM process: the Program Manager, the Project Manager and the Program and Project Management Officer.

3. Research Methodology

3.1. Research Strategy and Methods

An ethnographic research was carried out on a large university-industry R&D collaborative program case study, with the aim of learning from the expertise of program and project managers and other participants in the program. The research methods used in the case study were the document analysis and the observation of participants.

The study of several documents was carried out to better understand the context of the case study and to pinpoint risks, namely, the established governance model, the management record, which includes the identified risks and issues, among other aspects of the program, as well as several supporting documents for the management of the program and its projects. The observation of the participants played an essential part in the background of this research. It is a challenging research method [21]. In this case, participant observers entered into the social environment of the case study, following and participating in their activities, helping to develop their working practices. Diverse stakeholders were observed during the regular meetings. Thus, it was possible to understand the background of the organization and to identify the main RM activities.

3.2. Case Study Background

The case study here presented was the result of a strategic partnership established between University of Minho (UMinho) and Bosch Car Multimedia in Portugal (Bosch) in July 2012, targeting the development and production of advanced multimedia solutions for cars. Currently, UMinho is the main partner of Bosch Car Multimedia, S.A. in Portugal for R&D. This partnership, up to 2020, encompassed five R&D collaborative programs, spread over three successive phases of investment and sponsored by the Portuguese Government, using public competitive funds. The technological challenges approached by these programs ensured the development of knowledge applied into technologies and methods whose technological maturity ranges between Technological Readiness Levels 4 and 7.

UMinho is ranked in the top-150 of the world's newest institutions of higher education (aged 50 and younger), in the 2018 Times Higher Education ranking and is distinguished by the high level of collaboration with the Industry, with around 250 R&D agreements being subscribed annually with industrial partners.

Bosch in Portugal became one of the biggest automotive suppliers, manufacturing a wide portfolio of products such as navigating systems, instrument systems, car radios, steering sensors and electronic controllers. Bosch in Portugal allocates about 12% of its turnover to R&D activity.

HMIExcel was UMinho first collaborative R&D program with Bosch. The objective of this program was to design and produce new car multimedia solutions based on advanced Human Machine Interaction (HMI) systems. This program included 14 projects, was carried out between May 2013 and June 2015 and involved an investment of €19.3 million, around 300 UMinho researchers and Bosch employees. The HMIExcel program generated 174 deliverables, 12 patent applications by June 2015, and 32 technical and scientific publications.

The Innovative Car HMI (IC-HMI) program, included 30 multidisciplinary R&D projects aimed at product development, quality control and management of production. The IC-HMI program, with 30 projects simultaneously running from July 2015 to July 2018, involved an investment of €54.7 million, including about 500 researchers from UMinho and collaborators from Bosch, including the recruitment of 94 new collaborators dedicated to R&D at Bosch and 173 new researchers at UMinho. The IC-HMI program resulted in 417 deliverables, the submission of 22 patent applications and 72 technical and scientific publications. The set of benefits of the IC-HMI program, resulting from

several related projects, was reported in Fernandes, Pinto, Araújo and Machado [22].

The third investment phase of this partnership includes three programs, namely: Sensible Car (SC), Easy Ride (ER) and Factory of Future (FoF). This investment phase includes more than 50 projects, with a planned investment of more than €90 million, involving more than 500 UMinho researchers and Bosch employees.

UMinho and Bosch understood the importance of project management to support the management of this collaboration; and therefore, established a governance model. This model is based on the Program and Project Management (PgPM) approach [23], which was deliberately developed to support the management of collaborative university-industry R&D, financed contract programs and projects. As shown in Fig. 1, this approach includes a program management layer and project management layer.

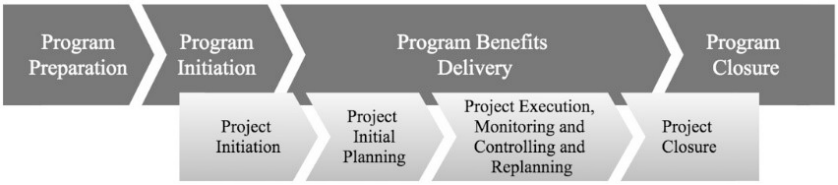

Fig. 1. PgPM approach adapted from Fernandes, Pinto, Machado, Araújo and Pontes [24].

UMinho and Bosch also invested in a dedicated infrastructure of the Project Management Office type – named Program and Project Management Office (PgPMO), which included members from Bosch and UMinho, who played the role of PgPMO Officers. The PgPMO has a supportive role [25], as its main objective is to support both Program Managers, Project Managers and their Teams throughout the lifecycle of the program and projects, namely in RM activities.

During the 'Program Initiation' phase, key stakeholders of the projects are involved in 'Alignment Workshops', organized by the Program Manager and supported by the PgPMO, with the aim of aligning the expectations and objectives of the involved collaborators before receiving funding. During these 'Alignment Workshops' potential risks of the projects are also identified. Then, the 'Program Charter' and the 'Project Charters' are created, with the support of the PgPMO Officers, to align the overall program aims with the aims of the individual projects. These 'Project Charters' also include all the initial risks identified in the 'Funding Application' and risks later identified during the 'Alignment Workshops'. During 'Program Benefits Delivery' phase, 'Progress Meetings' are held monthly between the PgPMO Officers and project teams, resulting in 'Project Progress Reports' that include up-to-date information about the project risks. These risks are then integrated in the 'Project RM Register' and in the 'Program RM Register'.

Moreover, during the execution and closing phase, great effort is made by the PgPMO Officers to identify, document, analyse, store and retrieve the lessons learned from each project and from the overall program, which results namely in a Risk Breakdown Structure (RBS) updated to support the risk identification of future university-industry R&D collaborations.

4. Results

A RM methodology is proposed to support the Program Management and the Project Management of university-industry collaborative R&D programs in RM. Fig. 2 presents this methodology, which includes a set of six integrated program and project key RM activities or processes. This RM methodology has as main theoretical framework the Standard for Risk Management from PMI [11] and, from an empirical point of view, the participant observation of the case study under analysis during five years.

The first key RM activity is the 'Plan Integrated Program and Project RM' that results from the R&D collaborative university-industry context analysis. This plan defines the RM activities to be applied throughout the program and project management lifecycles, with the aim to enhance and optimize the project and overall program results.

This set of RM activities or processes are conducted in a cyclical and continuous manner throughout the program and project management lifecycles. However, the periodicity of these RM activities has to be adapted to the needs of management, within the resources and time constraints, as well as the RM maturity of the various stakeholders of the partnership. In fact, the 'Plan Integrated Program and Project RM' identifies the RM methodology here proposed for university-industry R&D collaborations, which includes five more interdependent activities: 'Identify Risks';

'Conduct Qualitative Risk Analysis'; 'Plan and Implement Risk Responses'; 'Monitor Risks'; and 'Communicate and Integrate', as shown in Fig. 2. Considering the low maturity in RM observed in Bosch and UMinho case study, the quantitative risk analysis proposed by several standards [5], [11], [24] is not proposed here.

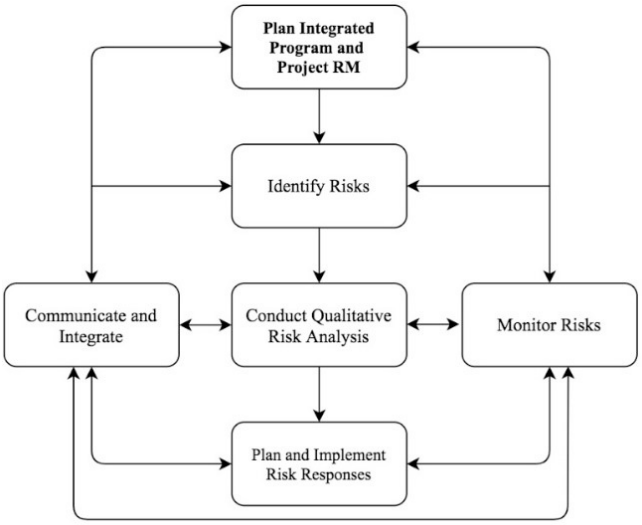

Fig. 2. Integrated program and project RM methodology.

The 'RM Register' is the central tool in a RM methodology [1] and it is used from the activity 'Identify Risk' and throughout the remaining RM activities. The 'RM Register' allows to record and easily access all the information about the risks, both at project and program levels, namely their identification, qualitative analysis, response plans and monitoring status. The 'RM register' in the Bosch and UMinho case study is an integral part of the general 'Management Register'. There is a 'Management Register' at the program level and another one at (each) project level. The 'Management Register' considers all information related to risks, issues, lessons learned, new project ideas and benefits of the program or project.

The risk event can be characterized by its causes and its effects on the objectives of the program or the project. The possible causes of risks are uncertainties related to the project or program, which might cause a positive or negative effect on its objectives. They can be identified through an assessment of the sources of risk, which, in addition to the environment, might be restrictions, assumptions, stakeholders, lessons learned, internal processes, standards, regulations, and others.

During the RM activity 'Identify Risks', it is also important to use the various categories of the RBS as input in order to assist the program management (at the program level) and project management team (at the project level). After identifying the risks, it is required to 'Conduct Qualitative Risk Analysis', qualifying the occurrence probability and the impact of each risk. The greater the probability and positive or negative impact, the greater the risk level. Typically, risk impact is measured in four dimensions: scope, time, cost and quality. Therefore, to evaluate the impact, the weight to be assigned to each parameter should be established by the Steering Committee, as they are responsible for the program success and can evaluate what is more important in that regard. The probability and impact can be qualified according to the parameters shown in Table 1.

Table 1. Parameters for qualifying the probability and impact of each risk identified.

Parameter	Probability	Impact
0	(Not applicable in probability)	No impact
0.1	Improbable risk, with very low probability of occurrence	Very low risk impact
0.3	Risk less probable, with low probability of occurrence	Low risk impact
0.5	Risk moderately probable, with moderate probability of occurrence	Moderate risk impact
0.7	Probable risk, with high probability of occurrence	High risk impact
0.9	Very probable risk, with very high probability of occurrence	Very high-risk impact

During the activity 'Plan and Implement Risk Responses', it is suggested that risk response strategies, such as presented in Table 2, be taken into account.

Table 2. Risk response strategies.

Threat	Actions	Opportunities
Accept	Do not take any action before the risk occurs, but may plan subsequent actions – Contingency Plan	Accept
Mitigate	Change the risk probability and/or the impact, by maximizing opportunities and minimizing threats, without taking the probability to 0% in the case of threats and 100% in the case of opportunities	Enhance
Avoid	Eliminate risk uncertainty, taking the probability to 0% for threats or 100% for opportunities	Explore
Transfer	Pass on part or all of the responsibility as well as the impacts to third parties	Share

When planning for the risk responses, the circumstances defining the type of risk response action, the starting period and the person responsible for the plan should be identified. Thus, for the choice of actions to be effectively adopted, the person in charge must adopt a response logic guided by the cost-benefit ratio between the level of inherent risk and the residual risk. The purpose of the risk responses is to change the initial risk level (inherent risk) to a new risk level (residual risk) that favours the achievement of the program or/and project success.

During the Bosch and UMinho case study, we observed a strong effort from the PgPMO Officers on drawing the attention of program management and project management teams to identify new risks, reassess the risk level and develop risk response strategies to risks. However, limited attention was given to these tasks by project managers and remaining members during these discussions, indicating the limited value recognized by managers to RM activities in the context of university-industry R&D collaborations.

Well performed RM activities are essential to R&D collaborations success [6] and particular emphasis should be placed on setting structured objectives, good monitoring of progress and effective communication and integration at the program and project level. Therefore, during this study detailed guidance is given to each of these six key RM activities from the perspective of the key management stakeholders, which are the Program Manager, Project Manager and PgPMO Officer, presented in Fig. 3.

5. Discussion and Conclusions

Based on RM literature review and the five years of the case study observation, the researchers proposed an integrated RM methodology with a stakeholders' perspective, identifying some of the most cited RM activities to be performed by key stakeholders during the program management lifecycle (see Fig. 3).

The main theoretical framework used for the development of this RM methodology was the RM standard from Project Management Institute [11]; however, the activities proposed by this standard are common to most project management standards, such as ICB [26] or ISO [27]. In fact, although this proposed RM methodology was developed for the specific context of collaborative university-industry R&D programs, we realized that these RM activities are in fact generic and can be applied to different program typologies.

During the university-industry R&D collaborative program case study from Bosch and UMinho we observed a low level of maturity on RM among key stakeholders. This was expected, as for example the human resources that commonly play the role of project managers are not project management professionals, but the project's Principal Investigators; so their main role is researching, not managing. Therefore, in this context, the PgPMO Officer plays a very important role by developing the integrated Program and Project RM processes and tools, embedding the RM activities in the program and the projects, supporting the Program Manager and Project manager in all RM activities, and maintaining all RM documentation up to date.

An important strength of the developed RM methodology is that it helps manage the risks brought by a university-industry collaborative program involving several projects, while emphasizing the importance of a stakeholder reality approach [18]. However, like any methodology, the RM methodology portrays a partial and incomplete view and should therefore be used cautiously by university and industry partners who can modify and adapt it to their own specific circumstances. Additionally, like any research based on just one case study, it has limitations on the generalization of results. The results are induced from one case and might thus be contingent upon its special context, and the reasoning may be influenced by random factors. In this regard, future studies can benefit from multiple case studies and crosschecking the conclusions among them.

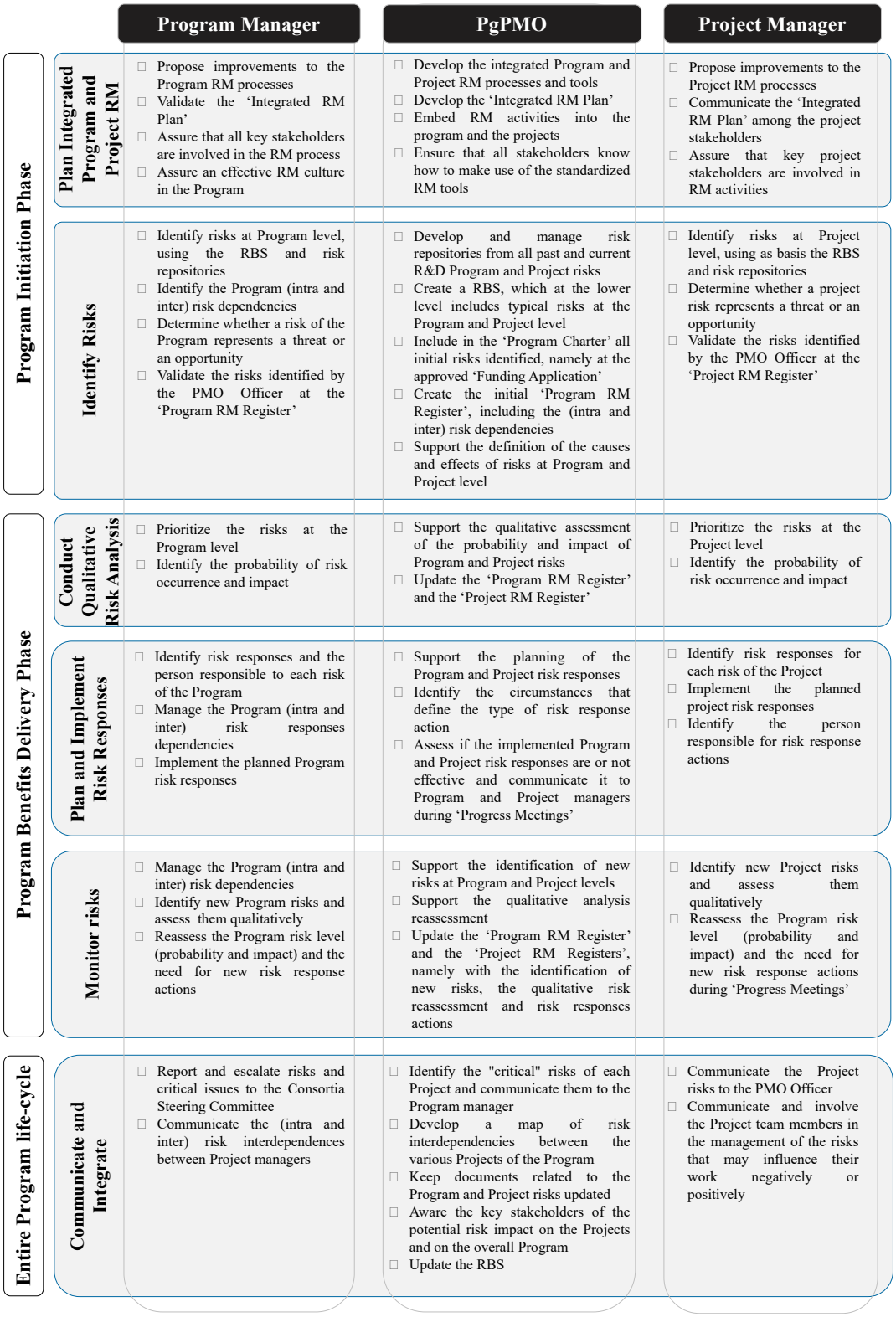

Fig. 3. RM activities: The Program Manager, PgPMO Officer and Project Manager's perspective.

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