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Perceptions of Different Stakeholders on Managing Collaborative University-Industry R&D Funded Contracts

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Abstract

A new program and project management (PgPM) approach especially devoted to support collaborative university-industry R&D funded contracts is being developed from an exploratory study. This paper describes how the identified key program management activities/practices are dependent on the program stakeholders' characteristics, namely contractual relationship - university vs. industry, professional category, role in the program context, PM experience, level of education, gender and age. A sample of 170 questionnaire responses from stakeholders of a real program, named HMIExcel, is used. There were few different perceptions observed between program stakeholders, which might indicate that the key program management activities within the PgPM approach are so relevant that there is a general consensus between different stakeholders.

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1. Introduction

Collaborative research projects between industry and university are increasing [1]. According to Brocke and Lippe [2] "Over the past ten to fifteen years they have received increasing attention in the project portfolio of public and private organizations as well as in the project management literature." Research and Development (R&D) collaboration provides various benefits to the collaboration stakeholders and societies. For example, it helps industries to encourage innovation and competitiveness, leading to more profits. Universities can enhance their academic results [3] and their sources of funding [4]. University-industry collaborations are encouraged by governments as a means of

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enhancing national competitiveness and wealth creation [5]. An example of large scale funding framework is the European Union Framework Programmes which supports multidisciplinary research and cooperative activities across Europe. Nevertheless, several countries support such collaborative R&D projects through national funding [6, 7].

Literature research concerning university-industry collaboration has concentrated primarily on the existence and effects of the so-called “cultural gap” [8]. The factors identified include conflicts over ownership of intellectual property, academic freedom to publish, differences of priorities, and time horizons. However, Barnes, Pashby and Gibbons [8] suggest that the majority of the problems associated with the “cultural gap” can be alleviated by good project management (PM). PM has been shown to deliver tangible and intangible benefits to organizations [9]. However, PM still remains a highly problematical endeavor. Projects still fail to live up to the stakeholders’ expectations as they continue being disappointed by projects’ results [10], namely in university-industry research projects [11]. Commonly cited reasons include the different motivations and objectives of the organizations involved [12].

PM is highly contingent on the organizational context, such as structure of business or industry sector, size, and its environment [13]. Cooke-Davies, Crawford and Lechler [14] argue that the value of PM is a function of what is implemented and how well it fits the organizational context, and as expected, projects in collaboration between two distinct organizations (university and industry) with different cultures and mind-sets and funded for an external body, have several specificities that require attention during the development of the approach to manage those joint initiatives.

While the literature provides some advice on managing program and projects [11], the specific context of university-industry collaboration demands a strong research effort to produce effective guidelines. With the increasing prevalence of university-industry partnerships and their importance to the future success of both organizations and to national economies, it is essential to discuss new innovative approaches to address the collaborations challenges.

A new program and project management (PgPM) approach especially devoted to support collaborative university-industry R&D funded contracts is being developed from an exploratory study [15, 16]. The format addressed in the PgPM approach is collaborative research programs, which means the work is carried out in a collaborative setting characterized by heterogeneous partners, in a specific application context provided by industry, with collective responsibilities, i.e. partners collectively plan, finance, and execute the project work, and supported through public funding agencies.

The research described in this paper aims to find if program stakeholders with different characteristics, in the quantitative study to assess the PgPM approach, identified different relevance levels of the key program management activities/practices during the program management life-cycle. The purpose is to understand the value perception of different stakeholders on the activities/practices proposed under the PgPM approach, therefore during the PgPM approach implementation in new R&D programs in collaboration between university-industry, special attention should be given to particular key program management activities/practices in particular program stakeholders.

The terminology activity/practice was adopted because although some of the program and project management practices are very well known and recognized practices by professional and academic community, others were identified during the conduction of this broad research study. They are activities, but aiming at becoming elicited as practices in the future.

The research partially reported in this paper builds knowledge in the domain of program and project management in the context of collaborative university-industry R&D funded contracts, by identifying how the different perceptions might be used to gain advantage in future programs.

The case study used is a collaborative university-industry R&D funded program between the University of Minho (UMinho) and Bosch Car Multimedia Portugal S.A. (BOSCH), named – HMIExcel. HMIExcel resulted from a strategic partnership established between UMinho and BOSCH in July 2012, regarding the development and production of advanced car multimedia solutions. The HMIExcel program has involved around 300 people within 14 R&D projects during two years (2013-2015), corresponding to a total investment of 19.2 M€ partially funded by the Portuguese Government as a national strategic project. Although HMIExcel for the funding body is seen as a project, its complexity and uncertainty led the consortium (UMinho and BOSCH) to manage it as a program.

The paper follows a common structure. The second section discusses the main theoretical foundation for the PgPM approach proposed and used in the HMIExcel case study. The third section makes a synopsis of the PgPM approach. The fourth section describes the research methodology applied and the fifth section presents the dataset used in the

research study reported here. The sixth section discusses the PgPM approach by exploring the perceptions of different stakeholders on managing collaborative university-industry R&D funded contracts. Finally, the main conclusions that emerged from this study, as well as, the suggestions for future work are discussed.

2. Relation to Existing Theories and Work

University industry research projects face many challenges concerning a successful PM since they are generally associated with high uncertainty and risks, significant pressure in terms of creativity and innovativeness, individually oriented project personnel, and project members which are settled at different locations [17, 18]. Therefore, research projects involving industry and academia, differ significantly from both development projects and “purely academic” research projects in the way they are planned, performed, and managed [19].

Understanding how to manage collaborative university industry R&D funded contracts and their particular issues appear to be limited [20]. However, there are still some reference models that give guidance to the implementation and practice of general program management, namely “The Standard for Program Management” from the Project Management Institute that describes the main generic phases of the program management life-cycle [21], the “Guidebook for Project and Program Management for Enterprise Innovation (P2M)” issued by the Project Management Association of Japan [22], and the “Managing Successful Programmes (MSP)” published and used by the Office of Government Commerce in UK [23] which is essentially a best practice framework that outlines how to best implement a long term program through a set of principles and processes. Chin, Yap, and Spowag [11] have developed a PM methodology particularly focused in university industry collaborations, based on leveraging leading PM best practices and on the examination of 19 structured interviews with university and SME (small and medium size enterprise) industrial partners. The basic structure of the PM methodology is divided into four modules outlined with processes for initiating, planning, executing, controlling, and closing projects with selected toolkits and templates for implementation. The key objectives, activities and outputs for each module are outlined.

Therefore, based on a review of the literature, a first conceptualization of the new PgPM approach (whose quantitative study is discussed in this paper) drew largely on three main theoretical foundations: 1) the “Project Management Body of Knowledge (PMBok)” from the Project Management Institute (PMI) [24]; 2) the “Standard for Program Management” from PMI [21]; and 3) the methodology developed by Chin, Yap, and Spowag [11].

The PMBoK was selected as one of the basis for the PgPM approach because it is one body of knowledge with the primary focus upon task execution. As argued by Morris et al. [25], the more tightly defined scope of the PMBoK is considered to be more accessible for practitioners than the wider range of the other Bodies of Knowledge. The third edition of the Standard for Program Management from PMI highlights the full scope of program management work in five performance domains (strategy alignment, benefits management, stakeholder engagement, governance, and life-cycle management). At the same time it illustrates and clarifies the program management supporting processes that complete the delivery of programs in organizational settings. The Standard for Program Management was selected as another basis for the PgPM approach due to the similitude of objectives, robustness, and multitude of organizational contexts. The Chin, Yap, and Spowage’s [26] work was also selected to base the PgPM approach because it is one of the few existing studies particularly focused in the management of university industry collaborative projects.

3. Synopsis of the PgPM Approach

The PPM approach makes a clear distinction between programs and projects. In programs covering a group of related projects, their management must be coordinated, and a synergy must be created to generate greater benefits than projects could do when managed individually [21, 23]. The management of a program of projects demands the management of all its constituent projects. Therefore, the PPM approach for collaborative university industry R&D funded contracts establishes a project management layer below the layer of the program management. A common and consistent set of management phases (see Fig.1) is being established with several key program and project management activities/practices already identified [16]. The terminology activity/practice was adopted because although some of the program and project management practices are very well known and recognized practices by professional and academic community, others were identified during the conduction of this research study. They are activities, but aiming at becoming elicited as practices in the future.

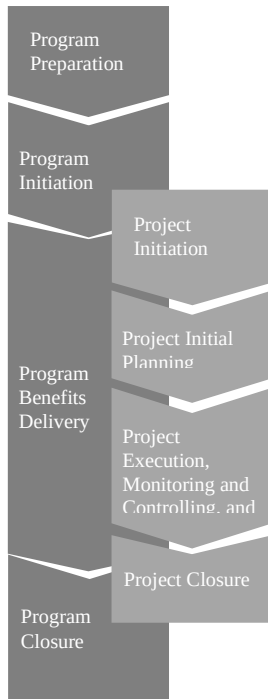


Fig.1. Program and project management lifecycle interrelation

4. Research Methodology

The research methodology that is being adopted to support the development of the new PgPM approach is the Ahlemann's framework and guidelines for conducting prescriptive PM research. The research methodology is divided into four phases: problem analysis; solution design; solution evaluation; documentation and communication. During these four phases different qualitative and quantitative research methods are used, namely observation, semi-structured interviews and questionnaire (for more detailed information see the previous works [15, 16]).

This paper reports on the data collected through a web-based questionnaire during HMIExcel closure phase (July and August 2015). In order to be able to quantify the program and project management constructs, respondents were asked to indicate the degree of importance of the questionnaire items on a 5-point Likert scale, where "5" indicates "very high" and "1" indicates "very low". The questionnaire items were all related to the improvement of performance of programs of projects similar to the HMIExcel program. The questionnaire was divided into four parts. A-D as presents Table 1.

The online questionnaire survey has elicited 170 completed responses from a total of 235 email invitations to the HMIExcel case study stakeholders, corresponding a rate response of 72.3%. The number of responses is sufficient for generalization of the results [27].

Data collected provided by the questionnaire were analyzed by using the IBM SPSS Statistics. Cronbach's alpha values for assessing the internal consistency of responses for each questionnaire part are much above both the 0.5 minimum and the 0.7 desired thresholds [28], which means the results are reliable. To detect differences in program management activities/practices related to the respondent's characteristics 'variables' (e.g. contractual relationship, PM experience, age, etc.) nonparametric tests were carried out. Although, parametric tests, such as ANOVA, are more robust [29], to use ANOVA, the four assumptions of parametric tests needed to be assured: normality, independence of the observations, the dependent variable should be measured on at least an interval scale, and homogeneity of the variances. However, the variables in sample violated the normality assumption, most of respondents answered 4 and 5 in the scale of Likert.

The non-parametric test most used was the Kruskal–Wallis test, as most of the independent variables have more than two categories, in the cases that the variables has just two categories, as the variable gender the Mann–Whitney U test was performed. The results of Kruskal–Wallis test just show that there are significant differences between categories within a respondent's characteristic variable; it does not provide specific information about which categories involve differences. Therefore, the post-hoc Mann–Whitney U test was performed, which helped to analyze the specific pairs for significant differences by the Mean ranks' computation [29].

Table 1. Questionnaire structure.

Part	Description
Part A	HMIExcel global appreciation. In order to find the degree of members' satisfaction, respondents were asked for several aspects of the HMIExcel program. Part A is out of the scope of this paper.
Part B	Program management activities/practices. 27 items having direct correspondence to the four program management phases (previously referred) completed the following question: " <i>Identify the degree of importance of the following activities on improving performance of similar programs to HMIExcel.</i> " (For details see Table I in [16]).
Part C	Project management activities/practices. 22 items having direct correspondence to the four project management phases (previously referred) completed the following question: " <i>Identify the degree of importance of the following activities on improving performance of similar projects to the ones ongoing in HMIExcel program.</i> " (For details see Table III in [16]). The project management activities/practices are not discussed in this paper due to the length restrictions.
Part D	Respondents' characterization. In order to find out any existing dependency between program and project management activities on the respondents' characteristics, participants were asked for information about themselves, their experience and work context (e.g., contractual relationship, role, PM experience, gender, age, education level).

5. The Dataset

The highest participation was from UMinho members and the outsourced external R&D entities associated to UMinho (62%), followed by Bosch (38%) from the total of 170 completed questionnaires. The primary professional role of the respondents within their employment contracts (independently of the performed role in the HMIExcel program) and the role within the HMIExcel program is shown in Table 2.

28% of participants have more than 3 years of working experience in R&D projects led by industry and involving one university, and 34% of respondents have more than 1 year of experience as project manager in any kind of project, from these, 16% have more than 5 years as project manager. The survey participants appear well qualified to provide valuable information.

33% of the HMIExcel participants were aged between 25-30 years and only 12% were over the age of 50 years. Most of the respondents were male (81%). A vast majority had at least a postgraduate degree (80%): 5% a postgraduate degree, 52% had a master degree, 19% a doctorate degree and 4% had "habilitation" qualification.

The sample is split evenly for many of the respondents' characteristics, which renders the analysis more reliable.

Table 2. Respondents' roles.

Role within the employment contract		Role within the program context	
Administrator or department director	11%	Program manager and Steering Committee member	4%
Senior engineer	9%	Project manager	17%
Engineer	22%	Project team member	69%
Junior engineer	2%	PMO team member	8%
Full professor	3%		
Associate professor	4%		
Assistant professor	8%		
Research fellow	4%		
Research assistant	35%		
Other	2%		

6. Results and Discussion

Table 3 presents the results of the post-hoc Man–Whitney U test under the program management activities/practices conceptualized in the PgPM approach for different program stakeholders' characteristics with significant category variations spotted within the Kruskal–Wallis test. Only the significant values $p < 0.05$ (Field, 2009) are presented. For example, in the first row of Table 3, the Man–Whitney U test shows that under the program management activity 'develop, in close collaboration between university and industry members, a document detailing the problem, objectives and potential solution of each initial project idea' there are significant differences between the two categories UMinho and Bosch ($p = 0.013$).

It was expected to spot more differences than the ones presented in Table 3. For example, the PM experience in collaborative R&D projects led by industry and involving a university did not influence the perceptions of the importance of different program management activities/practices.

In order to better apprehend the differences observed for different stakeholders' characteristics, it is discussed, for each difference: 1) what is the difference observed; 2) the researchers' reasoning explaining the difference; and 3) how the different perceptions may be used to gain advantage in future programs. So, the difference of perceptions found with statistical significance will be subsequently interpreted, with the expectation that the knowledge acquired will contribute to foster better future university-industry R&D collaborations. The desirable smoothness of the differences, always trying to approximate the lowest to the highest perception value, will be designated by "overcoming the differences".

Table 3. Perceived differences on program management activity/practice related to the respondents' characteristics.

Respondent's characteristic	Program phase	Program management activity/practice	Category1	Category2	Mann–Whitney (p)
Contractual relationship - university vs. industry	Program Preparation	Develop, in close collaboration between university and industry members, a document detailing the problem, objectives and potential solution of each initial project idea.	UMinho	Bosch	0.013
		Allocate project managers with technical and management competences.	UMinho	Bosch	0.041
Professional category (role within the employment contract)	Program Initiation	Ensuring the same effective start date of the program work for the university and industry (university can only allocate new resources after the investment contract sign-off).	Associate professor	Full professor	0.050
		Create a communication management plan.	Associate professor	Full professor	0.028
		Create a detailed program plan, which integrates all project plans of the program.	Associate professor	Full professor	0.013
Role within the program context	Program Initiation	Implement a PM software which assists in planning, monitoring and integrated control of the program and projects.	PgM or SC Member	PMO team member	0.013
Level of education	Program Benefits Delivery	Emphasize, besides the results achieved, the possibility of <i>industrial</i> implementation, during the program internal and external communications.	Postgraduate degree	Degree	
Gender		Collect systematically new projects ideas during the entire program life cycle, towards future R&D programs or projects.	Male	Female	0.014
Age	Program Closure	Make available to project managers a closure program report.	25-30	30-39	0.043

6.1. Contractual relationship - university vs. industry

Faculty members have scored higher (i.e., a higher percentage of respondents have selected 4 or 5 degrees of importance in the Likert-scale) on the program management activity/practice '*develop, in close collaboration between university and industry members, a document detailing the problem, objectives and potential solutions of each initial project idea*' than industry members.

The reasons behind this difference might be: 1) although, HMIExcel program has occurred under an effective and legal partnership, in several circumstances Bosch perceived UMinho as a supplier or a consultant, so the document in

question (which is the main input for developing the funding application) could have been understood as of the responsibility of faculty members; 2) typically, these documents are perceived by industry as being essentially theoretical, and so mostly understood as a faculty members competence; and lastly 3) industry members in general are not used to writing, as opposed to academics.

This difference might be overcome by: 1) promoting the interaction between industry and faculty members, through workshops, brainstorming sessions or simply meetings for discussion of the problem, objectives and potential solutions for the each initial project idea, without an explicit document up front; 2) clarifying the objectives of the funding application form filling - it should not be simply theory driven but encompassing the problems perceived by industry and also the scientific challenges required to be addressed in order to solve them; therefore, the industry members perspective is crucial; and 3) emphasizing, on the regular contacts, the nature of the relationship between industry and academia (partnership), and not a client/supplier relationship.

Faculty members have also scored higher on the program management activity/practice '*allocate project managers with technical and management competences*', i.e. they have perceived this activity as more important than industry members.

The reason behind this difference might be that members from UMinho perceived more the existent PM competence gaps than industry members. Although Bosch and UMinho had a representative in every structure of the program organization (ex. each project had a project manager from UMinho and a project manager from Bosch), the role of project coordination in its full extent was from UMinho project manager (more commonly named as project coordinator) with the support of the UMinho project management office (PMO) by systematically exposing the project teams with PM activities.

This difference might be overcome by continuously promoting actions in order to increase engagement of university researchers and industry collaborators, with distinct expectations, experiences and mind-sets [30] and by increasing the program stakeholders' perception on PM value [31].

6.2. Professional category

When comparing the survey results from different professional categories (role within the employment contract), Kruskal–Wallis test shows differences under three activities, all of them detected by Mann–Whitney U test, between the academic professional categories of associate professor and of full professor. Associate professors perceived less importance in all the three activities: 1) '*ensuring the same effective start date of the program work for the university and industry*'; 2) '*create a communication management plan*' and 3) '*create a detailed program plan, which integrates all project plans of the program*' than full professors.

The reason behind these differences might be that associate professors are not so much aware of the importance of PM activities; they see it as something bureaucratic and time consuming that they are required to do simply for work control purposes, not something that could help them to pursue their scientific and technical work, which is their main focus if they want to progress in the academic career. On the other hand, full professors are already on the top of the career, and typically to attain that level they had already several management positions and understood better the importance of PM activities and standardization of management practices to the program and projects success.

These differences might be overcome by increasing awareness especially from university partners of both perceived and actual benefits of PM, for example through more effective communication [32].

6.3. Role within the program context

PMO team members scored higher the activity '*implement a project management software which assists in planning, monitoring and integrated control of the program and projects*' than program manager and steering committee members.

The reason behind this spotted difference is not surprising, because PMO team members are very close to the operational management of the program and its constituent projects, while steering committee members have a more strategic management role. Therefore, PMO team members naturally have a higher importance perception of software tools to support them to deal with the vast amount of information to manage. In fact, as argued by several authors, PM software can play a major role in supporting the management of projects effectively and efficiently [33].

This difference might be overcome by increasing awareness especially on program manager and steering committee members of the importance of PM software, as they are responsible for this sort of investment decision.

6.4. Level of education

Respondents with a postgraduate (almost all from industry) degree scored higher the activity *'emphasize, besides the results achieved, the possibility of industrial implementation, during the program internal and external communications'* than respondents with a graduate degree.

Considering that a technical (engineer) professional who enrolls in a postgraduate program will do it to improve his/her professional performance to transform the acquired knowledge into practice, they better understand the importance of emphasizing the industrial implementation of the R&D project results. This difference may be overcome by systematically emphasizing its importance during communications, especially by industry top management.

6.5. Gender

Female scored higher on the activity *'collect systematically new projects ideas during the entire program life cycle, towards future R&D programs or projects'* than male respondents.

The reason behind this difference might be the assumption that female are less prone to risk than male. Therefore, the researcher's theory is that female look for stability in the medium and long term, therefore have perceived more importance of collecting new project ideas for guarantying the continuity of their work in future.

This difference may be overcome by promoting systematically the collection of new project ideas during the regular face-to-face progress meetings, organized by the PMO team members, as well as by promoting specific workshops to debate between all program stakeholders new ideas for partners future engagements.

6.6. Age

When comparing the survey results from different age categories only one difference was signalled between the respondents' category 25-30 and 30-39. Program stakeholders under the category age 30-39 have perceived more importance in activity *'make available to project managers a closure program report'* than program stakeholders under the category age 25-30.

This difference may be explained by the fact that respondents under the category age 25-30 had less experience in management activities than respondents under the category 30-39, and therefore have perceived less importance in this particular activity under the program closure phase. Additionally, in most cases, the closure phase activities are performed while new initiatives are already under way, thus people with less professional maturity may have more difficulty in understanding the importance of these closure particular activities.

This difference may be overcome by developing a common understanding of the institutionalized program and project processes, tools and techniques, their purposes and benefits, among all program stakeholders, as well as by increasing the perception of PM value.

7. Conclusion

To the best of our knowledge, this systematic analysis of the stakeholders' different perceptions on managing collaborative university-industry R&D funded contracts has not been published yet. This means that our findings, based on a formal quantitative research study, present new contributions, even if some of them may seem common sense.

The research partially reported in this article, add further information for universities and industries interested in increasing their performance in the management of collaborative R&D funded contracts, by taking into account the program stakeholders' characteristics, who have different perceptions of key program management activities/practices in order to gain advantage in handling collaborative R&D funded contracts. For instance, academies and industries with a young workforce may should give particular attention to program management activities/practices at the program closure phase, since stakeholders under the category age 25-30, perceived less value in such important

activities. Nevertheless, there were few different perceptions observed between program' stakeholders, which might be an indication that the key program management activities in the PgPM approach conceptualization are so relevant that there is a general consensus between different stakeholders.

Regarding some limitations of a questionnaire usage, namely its rigid structure, preventing the exploration of potential research findings, further work is planned, including the conduction of focus groups to get deeper insights, enriching the data that was previously collected through the questionnaire, and contributing for their qualitative validation.

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