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PMO IMPLEMENTATION FOR PROJECT MANAGEMENT IN A COLLABORATIVE RESEARCH CONTEXT

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Abstract
The management of collaborative research projects can present certain challenges, such as the development of multidisciplinary teams, ensuring alignment of the collaborative partners and generating the required level of impact from the project. The project management office (PMO) is an organizational unit designed to standardize how projects are delivered and achieve efficiencies through deploying best practice gained from the delivery of successive projects. Therefore, there is much scope for the PMO to support the management of collaborative research projects. This paper will provide an overview of how a PMO has been established at a higher education institution in order to support the development and management of collaborative research projects. The case study investigation includes a number of managerial insights on how the PMO structure and processes were implemented in a collaborative research context. These insights have been synthesized into a set of critical success factors for PMO implementation that will inform future research in this area and will also be of use to practitioners looking to implement a new PMO to support collaborative research projects.

Keywords
Project Management Office, PMO, Collaborative Research Projects.

Introduction
Research collaboration has increasingly become the norm for the pursuit of scientific and technological developments that require adoption of a multidisciplinary approach along with contributions from multiple partners (Lee and Bozeman, 2005). Multidisciplinary research collaborations have been described as being key to finding solutions to global challenges, such as the development of environmentally friendly technologies, enabling sustainable food production and the development of new medicines (Knapp et al., 2015). Indeed, many governmental funding agencies around the world actively commission collaborative research projects (Kardes, 2014) and promote knowledge transfer activities (Kochenkova et al., 2016) according to their funding requirements.

Collaborative research projects offer a number of benefits (Philbin, 2017), such as enabling the exchange of knowledge between collaborators, increasing the scope and scale of data generated by research studies, and allowing access to complementary research infrastructure (such as experimental equipment and numerical models). However, there are also certain challenges associated with research collaborations (Cummings and Kiesler, 2005), and these include the coordination costs, development of multidisciplinary teams, ensuring alignment of the collaborative partners, and generating the required level of impact from the project. Moreover, if collaborative research and technology projects are to generate potential solutions to address societal needs, across areas such as improved healthcare solutions, mitigating the effects of climate change and new forms of transportation, it is important that such projects can be managed to a high degree of success. This level of performance can be viewed in terms of achievement of the project milestones in the required timeframe and according to the quality, budget and schedule requirements, but this performance is also predicated on the research including the necessary creativity and scientific freedom to facilitate developments in the particular scientific or engineering discipline.

A potential mechanism to support the delivery of collaborative research projects is the project management office or PMO (Hobbs et al., 2008). The project management office (PMO) is an organizational unit designed to standardize how projects are managed and achieve improved efficiencies through deploying best practice gained from the delivery of successive projects (Philbin, 2016). The PMO provides management and administrative support to enable the delivery of projects and the PMO approach has been successfully implemented across a number of sectors, including construction (Qi et al., 2014), information systems (Ward and Daniel, 2013) and research administration (Wedekind and Philbin, 2018). Adopting a PMO structure has been associated with improved project performance and key drivers that support these improvements include the development of project standards and methods that detail best practice (Dai and Wells, 2004). The PMO acts as a knowledge broker not just between projects (i.e. sharing best

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practice across projects), but also between projects and senior management (i.e. supporting alignment of projects) (Pemsel and Wiewiora, 2013). Adoption of a PMO structure and corresponding management system allows common approaches, tools, techniques and infrastructure to be deployed as part of an integrated governance and management process to drive forward performance improvements for projects. Therefore, it is useful to investigate how the PMO approach to managing projects can be applied in a collaborative research context to ensure scientific and technological based projects are delivered both efficiently and effectively.

This paper is structured as follows. After the introduction there is a discussion of the broader collaborative research context, including the benefits as well as challenges of collaborative research projects. This is followed by the findings from the case study investigation of how a PMO has been established at a higher education institution in order to support the development and management of collaborative research projects. The case study will be used to synthesize a management framework to enable PMO design and implementation, including a set of critical success factors. This will be followed by conclusions and future work.

Collaborative Research Context

Collaborative research involves researchers working together to produce new scientific knowledge (Katz & Martin, 1997) and as such it is an integral feature of the academic strategy for research-intensive universities alongside education and knowledge exchange activities (Philbin, 2015). In terms of the broader research context, there appears to be an increasing trend towards research being collaborative in nature. Indeed, bibliometric research by Wuchty et al. (2007), based on analysis of 19.9 million papers and 2.1 million patents over 5 decades, demonstrated that teams increasingly dominate solo authors in the production of knowledge (see Exhibit 1).

Exhibit 1. Knowledge production patterns by academic field (source of data: Wuchty et al., 2007).

		Increasing team size		**RTI > 1 (with self-citations)**		**RTI > 1 (no self-citations)**	
Fields	N_{fields}	N_{fields}	**%**	N_{fields}	**%**	N_{fields}	**%**
Science & engineering	171	170	99.4	167	97.7	159	92.4
Social sciences	54	54	100.0	54	100.0	51	94.4
Arts & humanities	27	24	88.9	23	85.2	18	66.7
Patents	36	36	100.0	32	88.9	–	–

This large-scale study included ISI (Institute for Scientific Information) Web of Science data covering research publications from science and engineering since 1955, social sciences since 1956, arts and humanities since 1975, and US registered patents since 1975. Exhibit 1 highlights the number (*N*) and percentage (%) of the subfields that exhibit larger team sizes in the last 5 years compared to the first 5 years. The data was based on the relative team impact (RTI) for a given time period and field, where RTI is the mean number of citations obtained by team-authored work divided by the mean number of citations obtained by solo authored work. The data shows that in the case of science and engineering (with no self-citations), 92.4% of the 159 subfields have experienced increased levels of collaborative activity, with the corresponding figures for social sciences and arts & humanities being 94.4% (51 subfields) and 66.7% (18 subfields) respectively. This data therefore indicates that there is an increasing trend of scientific research studies being delivered by collaborative teams.

In regard to the trend towards international collaboration, we can consider data from the United Nations Educational, Scientific & Cultural Organization (UNESCO, 2015). Exhibit 2 provides data on the percentage (%) of publications with international co-authors from 2008-2014. The data is based on total publications across all major fields of science, and is provided for the top 12 countries based on total number of international publications. This highlights, for instance, that 55.9% of scientific publications from the United Kingdom (UK) involve international co-authors, while the figures for USA and Japan are 34.8% and 27.1% respectively. Although there are variations between countries, it is evident that international research collaboration is a prominent feature associated with the delivery of modern science and technology.

We can also consider the case for universities collaborating with industrial companies. On this matter, Calvert and Patel (2003) carried out a bibliometric study that identified 22,259 joint university and industry co-authored

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publications from 1981 to 2000 in 5-year periods (see Exhibit 3). Data was obtained from the Institute of Scientific Information (ISI) on publications from UK universities, but it included both domestic and foreign companies. The research study categorised publications according to the following areas: agriculture/agronomy, biology related, civil engineering, chemical engineering, chemical sciences, computing, earth sciences, electrical and electronics, engineering, instrumentation and measurement, mechanical engineering, medical, mathematics, materials, multidisciplinary, physics, and other engineering. The authors also looked at the industrial sector and found that the largest volume of publications came from the pharmaceutical sector. Moreover, their analysis highlighted that the number of university and industry co-authored publications has increased from 2,931 in 1981-85 to 8,366 in 1996-00. They also found that the percentage of such publications initially increased over the 5-year periods, although this appeared to level off for the final 5-year period, i.e. 1996-00. Nevertheless, this work highlights the growing level of collaboration between universities and industrial companies as evidenced by the increasing number of co-authored publications.

Exhibit 2. Level of international co-authored publications per country (source of data: UNESCO, 2015).

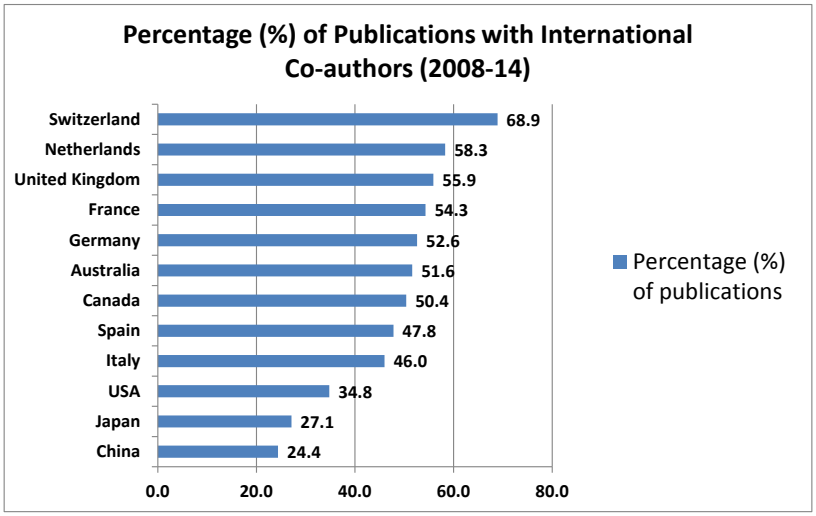
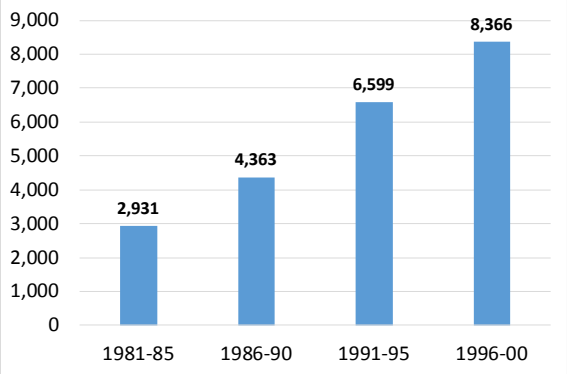
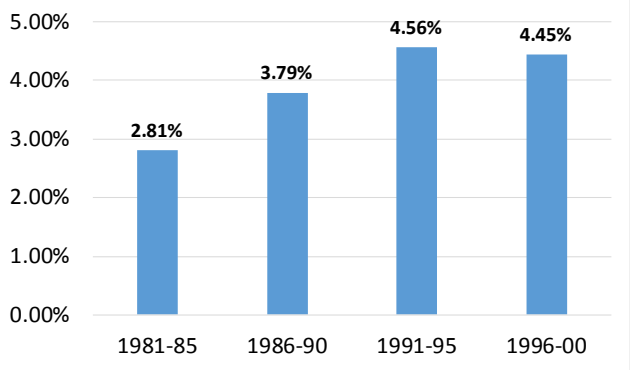


Exhibit 3. Number of university and industry co-authored publications (left) and as a percentage of total publications (right) from the UK for 1981-85 to 1996-00 (source of data: Calvert and Patel, 2003).





It is also interesting to note the work by Beaver (2004), which identified that collaborative research appears to be more likely to be cited than singly authored research. This finding was based on bibliometric research from USA on the work of 33 different authors at a single academic institution and a final data set of 482 papers from journals with an ISI (International Scientific Indexing) impact factor. The longitudinal study found that the average (citations x impact factors)/paper was 48.8 for publications with one academic (without students) but was 134.3 with one or more academics (without students). This would seem to indicate that publications with one or more academic have a

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higher level of citations (through taking account of the journal impact factor). The same pattern, although much less marked, is also observed for the case of publications with students.

Exhibit 4. Average (citations x impact factors)/paper (source of data: Beaver, 2004).

Type	Without students	With students	Average
One academic	48.8	24.9	36.9
One or more academics	134.3	42.0	88.2
Average	91.6	33.5	62.6

Focusing on the case for collaborative research projects, a number of benefits for the researchers involved can be identified, and this includes researchers based at higher education institutions as well as those at other organizations, such as government labs, research institutes, and industrial companies. These benefits have been assembled based on the authors' experience in managing collaborative research projects funded from a range of sponsoring organizations over the past 20 years and are summarized in Exhibit 5.

Exhibit 5. Benefits for collaborative research (source: author's experience).

Benefits for conducting collaborative research projects
• Enable researchers to work together in order to complement their skills and knowledge.
• Allow the exchange of information and knowledge between collaborators.
• Enable multidisciplinary research studies to address major technical challenges, e.g. societal, industrial, or knowledge-driven challenges.
• Provide access to specialized equipment, numerical models, or other research infrastructure.
• Support the expansion of the field of data available for research studies.
• Provide scope to explore joint publishing opportunities.
• Support researcher mobility between institutions.
• Help secure governmental research funding designated for supporting collaborative projects.

While there are compelling reasons to undertake collaborative research projects, there are also certain challenges associated with managing such projects. These challenges can be articulated in terms of the technical, commercial, and social-based (or people) aspects of the projects. Exhibit 6 provides a summary of the challenges for managing collaborative research projects, and these insights are also based on the authors' experience in this area.

Exhibit 6. Challenges for collaborative research projects (source: author's experience).

Technical	Commercial	Social (People)
• Availability of research resources (namely staff, facilities, materials).	• Availability of funding (industry, government, or other).	• Managing the contributions from multiple partners.
• Maintaining research quality while meeting schedule, cost, and quality requirements.	• Ensuring the financial costing captures all the project costs.	• Managing delivery across international borders, different languages and cultures.
• Generating sufficient 'impact' over the required timeframe.	• Lack of a robust business case to support the project.	• Insufficient leadership of the project, either academic or commercial.
• Inadequate planning of technical aspects of the project.	• Flexibility in commercial arrangements, e.g. for IPR (intellectual property rights).	• Establishing effective multidisciplinary teams.
• Ensuring alignment with industry needs (in regard to products and services).	• Other legal matters, especially for international contracts.	• Maintaining regular and open communications with partners.

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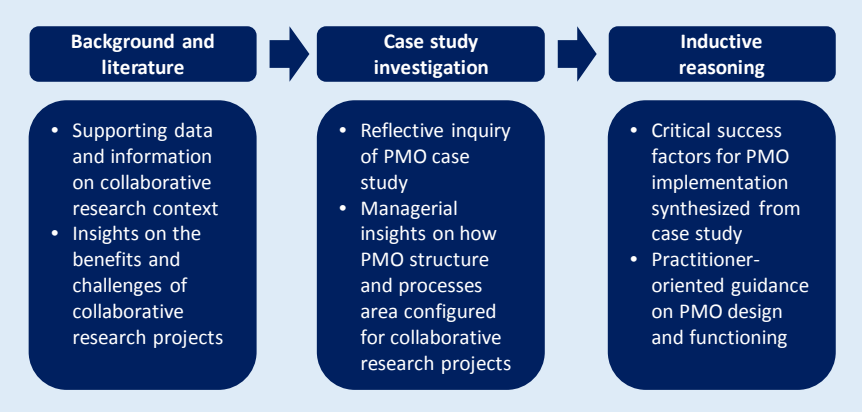
Method

The method employed in this research study is centered on a case study investigation of the Programme Management Office (PMO) at a university from the United Kingdom where the author was employed. The case study involved exploration through a process of reflective inquiry (Schön, 1987) by the author in order to discern the project management issues associated with PMO implementation and especially in the context of collaborative research.

The case study was augmented by a review of the collaborative research context (i.e. background and supporting literature) and consideration of the issues related to project management and the PMO. Moreover, a process of inductive reasoning (Feeney and Heit, 2007) was used in order to synthesize of set of critical success factors for the PMO. This inductive reasoning is a process that allows a specific instantiation to be analyzed in order to derive a generalized set of findings. While this approach may not offer the epistemological features of a fully quantitative approach (Ketokivi and Mantere, 2010), it does nevertheless provide useful and practical insights into a particular situation and for the case study the insights relate to the design and functioning of the PMO. For further information on the process of developing critical success factors, see the work of Boynton & Zmud (1984), and Belassi & Tukel (1996). Exhibit 7 highlights the main components of the methods scheme adopted in this research study.

Exhibit 7. Main components of the methods scheme.



Case Study Investigation

The PMO was formed with the mission to support the delivery of academic-driven collaborative projects. These projects involve contributions from the university along with inputs from collaborative partners, including other universities as well as research and commercial partners. The projects are funded from a range of different sources, including the European Commission's Horizon 2020 programme as well as other international funding organizations. The PMO team has a number of core capabilities, which are depicted in Exhibit 8. This includes consortium management, project management and commercial services as the main functional areas, which are supported by process and systems management. The PMO provides coordination and oversight, which is ultimately driven by the need to deliver academic value across the university. The PMO operates via a structured set of management processes, geared towards the needs of academic teams working on collaborative research projects and this is undertaken according to recognized best practice for project management along with robust processes to ensure that benefits are realized and risks are properly managed.

The PMO supports academic teams across the university to deliver two main types of technical projects, these are European Commission funded consortium projects and academic-driven commercial projects. Both of these types of projects directly underpin achievement of the university's organizational strategy. Moreover, it is important that the PMO's scope of activities and projects are strongly aligned with the strategic direction of the university. This alignment and positioning of the PMO as well as the two main types of projects supported is conceptualized in the strategy diagram in Exhibit 9.

The resources available to the PMO include staff and non-staff areas as part of a clearly defined organizational structure. The PMO team includes a team leader (director), project managers, back-office operations and administrative team as well as other specialists, such as a contracts manager. The team works together to enable management support to be provided to the two main types of projects and in accordance with the PMO level strategy that is closely aligned with the university's organizational level strategy. The team possesses the required levels of

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experience and knowledge to ensure high quality project management is available and this includes the necessary project management certification (namely the European PRINCE2 standard) that is held by team members.

Exhibit 8. Core capabilities of the PMO.

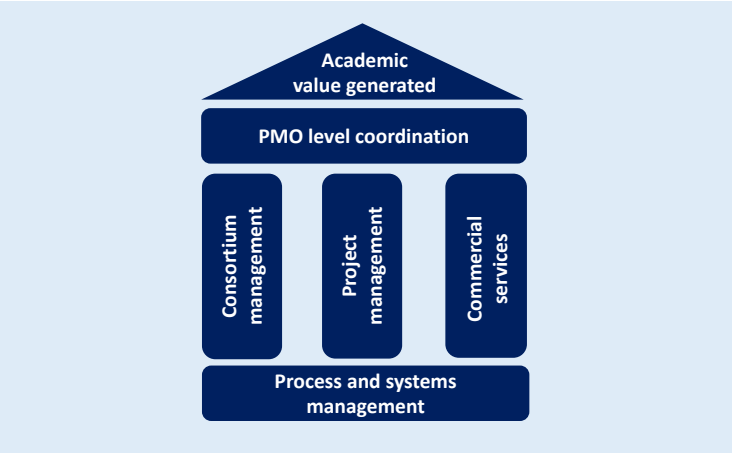
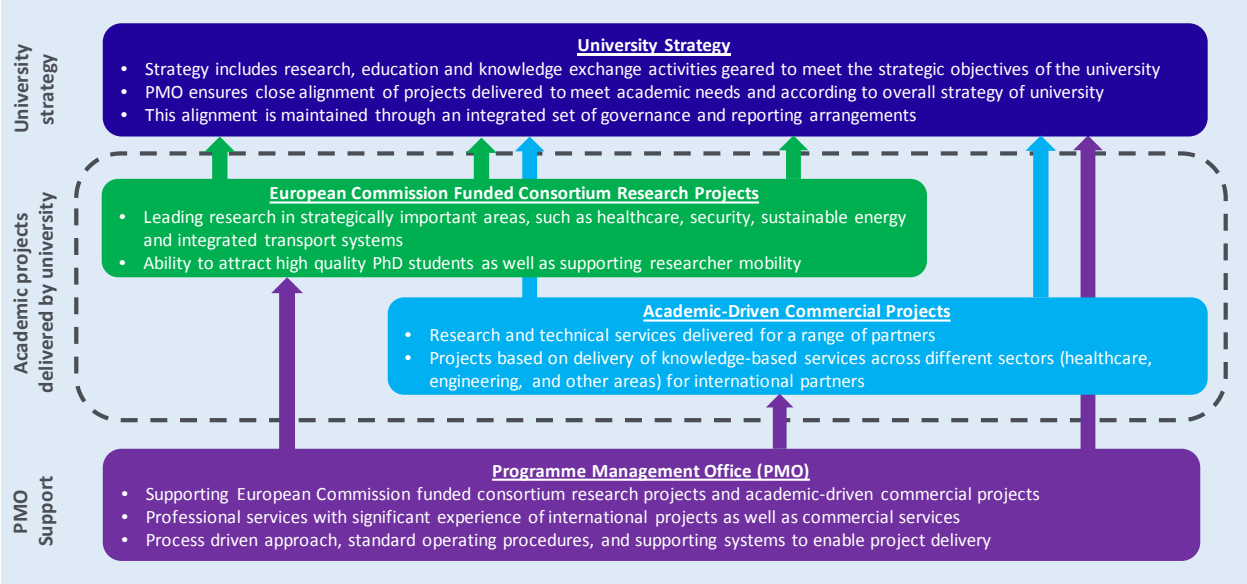


Exhibit 9. Strategic alignment of the PMO and projects supported.



As mentioned previously, the PMO provides project management for two main types of projects and it is useful to consider further details on these projects (see Exhibit 10).

Exhibit 10. Features and details of project types supported by the PMO.

Project type	Project features	Sector/areas	Project outputs	PMO services
Consortium research projects	Projects involve a number of consortium partners (universities, research institutes	Projects across various aspects of healthcare, including paediatrics and other areas (low	Research outputs, including PhDs graduated, publications, papers, etc.	Provision of project management for the overall consortium, managing project

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	and companies) working together, typically over 4-5 years to achieve a series of research goals.	TRL). Also engineering projects involving the development of new technologies (mid-level TRL).	Impact generated across societal aspects (improved healthcare), industrial development and economic outputs.	delivery and periodic reporting, communication and knowledge dissemination activities.
Academic-driven commercial projects	Projects involve the delivery of technical services for partners, based on knowledge-driven activities, such as analysis, advisory services and testing.	Projects are across healthcare and engineering sectors, typically at a high TRL level in most cases.	Knowledge-exchange with commercial partners, capacity building with international partners, improved technical capacity and knowledge provision.	Provision of project management, including tracking deliverables and milestones. Also commercial and financial administration activities.

As can be observed, the two main types of projects have different features and characteristics. The consortium projects are research-based, with much of the project management being focused on supporting delivery of consortium-based activities across the various partners. The projects include fundamental research at a lower TRL (technology readiness level), such as TRL1-3 as well as technology development projects with a mid-level TRL of 4-6. Conversely the academic-driven commercial projects are typically at the higher TRL level of 6-9. For further information on the use of technology readiness levels to characterize research and technology at the different stages of development, see the work of Mankins (2009) and Moorhouse (2002). Also, the commercial projects involve the delivery of various knowledge-based services, such as technical analysis, advice and testing.

Both types of projects are supported by project management delivered by the PMO, although the emphasis of the management support varies and is tailored according to the needs of the project and the academic team. In the case of consortium projects, project management is focused on supporting the project's PI (principal investigator) to deliver the research objectives across the consortium of partners. Conversely, in the case of the commercial projects, the project management includes the traditional management of deliverables and milestones combined with commercial services, including contractual and financial administration. Delivery of the project portfolio is based on the provision of project management across the full project lifecycle, including supporting pre-award (proposal development) and post-award (project delivery) activities. The provision of high quality support to academic teams requires close working with other professional services teams at the university as well as providing close support to the principal investigators. This work is supported by internal communications (including in-reach events, workshops and other activities) as well as external communications (including websites and other social media).

Adoption of an integrated communication strategy therefore supports the development of new projects, maintaining the project portfolio and helping to underpin the financial sustainability of the PMO team. Moreover, the project portfolio is delivered through a series of tailored management processes designed to ensure projects are properly controlled and progress is monitored through project and team level reports (including use of key performance indicators and the balanced scorecard). The provision of high quality project management (as evidenced by academic and customer derived feedback as well as achievement of project objectives) is also dependent on access to the necessary management tools, standard operating procedures (SOPs) and systems including appropriate cloud-based ICT (information and communications technology) infrastructure. These aspects are delivered as part of an integrated management framework that underpins the effective and efficient operational performance of the PMO and corresponding projects.

Critical Success Factors for PMO Implementation

The case study investigation has allowed an exploration of the PMO implementation in the context of collaborative research projects, including discussion of the various activities, processes and features of the implementation. It is possible to analyze the specific insights from the case study and through a process of inductive reasoning to synthesize a set of critical success factors for PMO implementation, which are depicted in Exhibit 11. Further details on the critical success factors as well as key sub-areas are provided in Exhibit 12.

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Exhibit 11. Critical success factors for PMO implementation.

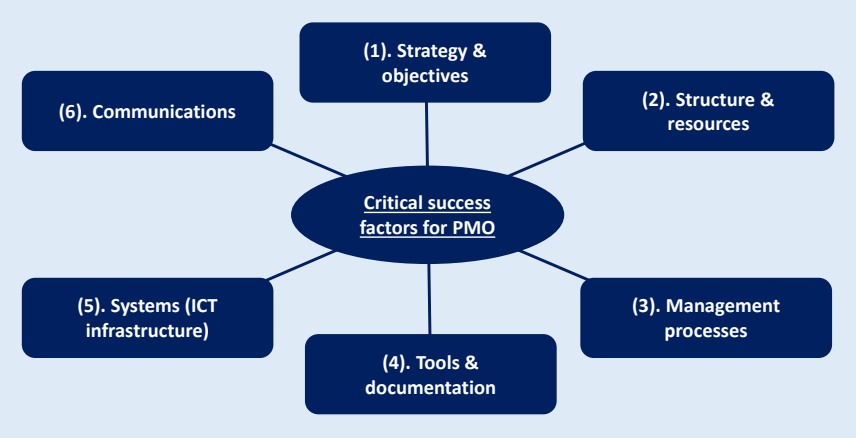

Exhibit 12. Further details on PMO critical success factors and key sub-areas.

No.	Success factors	Key sub-areas
(1).	Strategy and objectives	• Team strategy aligned to organizational level strategy. • Clear direction on projects, including types of projects (such as funding source, technical area, and scope of services).
(2).	Structure and resources	• Organizational structure that is fit-for-purpose. • Project management, operational and administration staff. • Certification for project management and associated training provision.
(3).	Management processes	• Regular reporting of project progress to ensure delivery according to schedule, budget, specification and quality targets. • Key performance indicators (KPIs) tracked via team scorecard.
(4).	Tools and documentation	• Standard operating procedures (SOPs) adopted across key management processes. • Templates, tools and other documentation available to the team.
(5).	Systems (ICT infrastructure)	• Corporate systems, including ERP (enterprise resource planning) and CRM (customer relationship management) systems. • Local systems, e.g. project management system, Kanban reporting systems and others as required.
(6).	Communications	• Internal and external stakeholder engagement through events, workshops and other meetings. • Websites and use of social media channels to raise awareness of the team and project level performance.

Conclusions and Future Work

This paper has provided a discussion on how collaborative research projects can be delivered through implementation of a PMO approach to support the project management process. The wider context of research collaboration has been surveyed, including supporting data that indicates there is an increasing prevalence of research being conducted by collaborative teams and this extends to cases where universities are collaborating with industry. Furthermore, the level of international collaboration is apparent when considering technical publications although the exact level varies across different countries. The benefits of collaborative research projects have been identified along with the management challenges in terms of the technical, commercial, and social (or people) related dimensions. This context provides fertile ground for the PMO to make a positive impact in supporting both the development and management of collaborative research projects. This is relevant not just in higher education institutions but also in other organizations involved in conducting research, e.g. government labs, research institutes, hospitals, and corporate entities. The case study investigation of a successful PMO team that has been operational at a UK university for a period of four years has allowed a number of features and corresponding insights to be generated on PMO

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implementation. In the context of collaborative research, these insights have been synthesized into a set of critical success factors for PMO implementation.

The PMO approach to supporting research collaborations offers a number of benefits as identified by this research study. However, any such approach is dependent on securing both senior level support within the organization as well as the active involvement of faculty members (or principal investigators). Moreover, a centralized PMO team can develop best practice and standard operating procedures for managing large and complex research projects – in the case of this study many being international. Therefore, when designing a new PMO it is useful to consider the following critical success factors: strategy & objectives, structure & resources, management processes, tools & documentation, systems/ICT infrastructure, and communication. Additionally, in order to be sustainable, any PMO needs to be positioned to develop a pipeline of new opportunities and projects – and this is dependent on continued high performance. Indeed, it takes time and effort to set up all the supporting areas for a PMO team (such as management processes, systems, communication channels, and documentation). But all this effort is worth it when the planning is realized and a portfolio of major research projects are secured – resulting in high-quality support provided to research teams across the organization. Finally, it can be said that the work of the PMO is projects, but it is very much the people who make it all happen.

Future work is suggested to further explore the validity of the critical success factors for PMO implementation identified in this research study and a multi-organization empirical study is proposed using a mixed method approach, such as use of a survey instrument combined with semi-structured interviews. Also, further work is suggested on how agile project management can be adopted as part of the PMO approach and especially for research and technology projects.

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Simon P Philbin recently joined London South Bank University in the United Kingdom as Professor and Director of the Nathu Puri Institute for Engineering & Enterprise. The Institute is focused on driving enterprise into engineering education and industrial practice. Prof. Philbin previously worked as Director of Programme Management at Imperial College London, where he founded and led the Programme Management Office (PMO). While at Imperial and over 15 years he held a number of senior roles associated with both pre-award and post-award management of a range of multidisciplinary research areas and programmes. Prior to joining Imperial in 2003, he was at the UK Ministry of Defence and originally worked in the field of energetic materials. Prof. Philbin is published across several areas including project management, research & technology management, and chemistry. He has presented at conferences across North America and Asia and given lectures and seminars at several different universities. Prof. Philbin holds a BSc and PhD in chemistry as well as an MBA.

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