sustainability

MDPI

Article

Role of the Project Management Office in University Research Centres

Gabriela Fernandes [1,*], Hugo Sousa [2], Anabela Tereso [2] and David O'Sullivan [3]

[1] CEMMPRE, Department of Mechanical Engineering, University of Coimbra, 3030-788 Coimbra, Portugal
[2] ALGORITMI, Department of Production and Systems, University of Minho, 4800-058 Guimarães, Portugal; hugo.sousa@eng.uminho.pt (H.S.); anabelat@dps.uminho.pt (A.T.)
[3] School of Computer Science, National University of Ireland Galway, H91 TK33 Galway, Ireland; david.osullivan@nuigalway.ie
* Correspondence: gabriela.fernandes@dem.uc.pt; Tel.: +351-239-790-790

Abstract: University Research Centres (URCs) have become a primary organisational structure in universities for bringing together a critical mass of multidisciplinary research interests that can compete for large, funded research projects and create breakthrough research results. Some of the more successful URCs are now developing specialised project management offices (PMOs) that can coordinate key activities, from proposal development to project execution, and ensure that research results are disseminated. A key challenge for URCs is to define what roles, functions, and competencies such a PMO should have. This research identifies a number of key attributes of PMOs that meet the unique challenges of URCs. This paper presents an initial conceptualisation of roles and functions developed from a literature review and that are later tested via a detailed survey among 370 URC participants involved in collaborative R&D projects worldwide. The study suggests that there are three PMO maturity stages: 'basic', 'intermediate', and 'advanced'. The resulting conceptualisation highlights six functions for a 'basic' PMO stage, an additional ten functions for an 'intermediate' PMO stage, and a further ten functions for 'advanced' PMO. The research presented provides guidance and decision support to URCs when selecting the role that a PMO should play for achieving tangible and intangible project benefits. Although the study suggests a lengthy list of functions, none of these should be considered in isolation. Most of the functions interact with each other and affect the PMOs' impact within the URC in various ways. The paper contributes to the transformative and evolutionary nature of PMOs, and illustrates that universities are receptive and even demanding of the need to create an effective PMO to improve the operation of major R&D projects and programs and create greater societal impact by URCs.

Keywords: project management; project management offices; PMO role and functions; university research centres

Citation: Fernandes, G.; Sousa, H.; Tereso, A.; O'Sullivan, D. Role of the Project Management Office in University Research Centres. *Sustainability* **2021**, *13*, 12284. https://doi.org/10.3390/su132112284

Academic Editors: Raquel Castro Madureira, Marlene Amorim, Marta Ferreira Dias and Cláudia Margarida de Sousa e Silva

Received: 7 October 2021
Accepted: 3 November 2021
Published: 7 November 2021

1. Introduction

Markets have never been so competitive and globalised, and for that reason, organisations need to create more innovative and faster response mechanisms to remain competitive and survive [1]. Consequently, organisations are increasingly involved in more multidisciplinary and cross-institutional research, provided namely through University Research Centres (URCs) or institutes [2]. The URC is one of the most attractive external sources of knowledge and technology for industry [3]. They create opportunities for closer relations between universities and industries and for knowledge development and technological advancement [4]. URCs link researchers from different multidisciplinary areas to cope with complex projects [5]. There is no consensus in the literature on the definition of URCs due to their heterogeneity and the wide diversity of objectives and characteristics [6,7].

A URC can be defined as an organisational entity within a university that aims to serve a multidisciplinary research mission [8]. It is usually separated from the departmental

or school structures and includes researchers from more than one department [5]. Their primary function is to generate new knowledge that holistically encompasses theories and applications from multiple disciplines that generally do not come together in traditional department-based academic settings [5,7,9]. URCs are public or private non-profit institutions and represent a fundamental pillar in consolidating a modern and competitive scientific system [7].

Existing literature points out the advantages and disadvantages of URCs. Literature has shown that URCs can lead to positive outcomes for faculty members in the form of increased publication productivity [10–12], collaboration and networking [9–14], industry partnerships [15], and technology transfer [5–17]. However, some authors argue that URCs can also be a source of conflict with the values of academic departments and schools [18,19]. In addition, affiliation with a URC can result in competition among faculty members during workload planning and resource allocation [7,20,21].

URCs focus on scientific research and technological development, organised as projects, and in this respect project management (PM) plays an important role. PM aims to execute projects in terms of time, cost, scope and quality requirements, in addition to meeting project goals, managing risks, and creating value and societal impact [22]. In this respect, PM is a complex set of skills and competencies.

Increasingly, universities and URCs are looking to develop Project Management Offices (PMOs) to enhance PM skills and organisational learning [23]. PMOs that harness key PM capabilities can drive strategy implementation and provide more value [24,25]. Consequently, URCs that utilise these organisations will be more likely to be ranked above their competitors [26].

A PMO is a dynamic organisational structure, which is both part of and interacts with the broader organisation, to solve specific organisational problems [27]. It may appear either alone or as one of a number of sub-structures with responsibility for project governance [28]. Existing literature on the integration of PMOs within organisations refers mainly to functional understanding and standardised tools and software applications [29,30].

Complex organisations such as large corporations are evolving the implementation of PMOs, often opting for multiple PMOs, which do not function as isolated units but have high interdependencies [28]. PMOs are used in several sectors of activity, including research administration [31]. There is academic research on PMO structures within commercial organisations [22,32,33], but there is limited literature on the existence of PMOs at universities or URCs. Sergeeva and Ali [34] have shown that PMOs play an important role in coordinating and stimulating innovation and delivering projects successfully within URCs. Widforss and Rosqvist [35] also studied the functions of the PMO in this context. They grouped functions into two stages: (1) pre-award, i.e., to scout for new funding and new projects, and to support the funding application process, from counselling to writing the proposal and coordinating the application process; and (2) post-award, i.e., to assume the responsibility for the project governance, with a focus on the planning period; to write, scrutinise and finalise agreements and contracts, including arranging administrative start-up meetings; to support reporting on project execution and its closure, and to provide PM skills and resources in large and complex projects.

There is a gap in knowledge regarding the conceptualisation, typologies, and roles of PMO structures in URCs. This paper addresses some of these gaps by answering the research question: How can PMO structures be developed to support project management in a URC context? More specifically, the research reported in this paper aims to conceptualise PMO roles and functions for URCs. The methodology adopted is based on survey research through the questionnaire method and involved factor analysis. This paper contributes to theoretical knowledge in two essential ways. Firstly, it presents a new conceptualisation of PMO roles and functions in URCs, which are organisations substantially different from companies, namely, in the form of financing [36]. In companies, the most common forms of financing are bank credit, leasing, business angels, and venture capital. In URCs, funding can be provided through universities where they are integrated, through partnerships

between industries and universities, and national or international funds. Secondly, the conceptualisation of PMO roles and functions contributes to PMOs' transformative and evolutionary nature. The paper also shows that researchers at URCs are highly receptive to creating a PMO structure for improving the performance within their URC projects and programs. Finally, this research contributes to practice for supporting the implementation of PMOs in the context of URCs.

The paper begins with a literature review on the context surrounding URCs and PMOs. It then develops an initial conceptualisation of PMO structures to be used later in the study. The research method used for data collection and analysis is then described. Research results based on factor analysis are then presented. Finally, a conceptualisation of the PMO structures for URCs is discussed and concludes with the management implications and underlining pathways for further research.

2. Background

2.1. University Research Centres

URCs are becoming more common to specifically address the increasingly complex nature of scientific problems that require research solutions that span multi-disciplinary and institutional boundaries [20]. URCs typically bring together researchers from several disciplines and ideologies, different institutions (universities, companies, governments), countries and cultures to solve complex scientific and social-scientific problems [37].

In general, universities and faculty members have benefitted greatly from the presence of URCs. On the one hand, URCs can attract new faculty to collaborate by offering resources and additional funding [38] and allowing faculty members to extend their research agendas [39]. On the other hand, URCs improve the quality of university education since they can attract quality graduate students and enhance comprehensive graduate education [16,39]. They also facilitate interdisciplinary research and collaboration between experts [5,7,9]. URCs are a platform for faculty to focus on their research agendas and gain resources not normally available through academic departments [10,40,41].

These alliances between universities and institutions for the creation of URCs have changed the way the organisational structure of URCs is defined and established [42]. Some URCs are housed within an academic department and adhere to the administration of the department. Other centres function as separate entities within the university. They are governed by an external dean or other authority [7,43], which illustrates that the functions of the URC can differ in their organisational structures and hierarchy within the university. URCs are perceived as specific mechanisms by which institutions create organisational bridges that go beyond the limits of cultural and structural differences [44]. URCs help research projects accumulate scientific knowledge and provide support for increased publication productivity [17,45].

While URCs benefit from conducting research projects due to the plurality of their activities, there are also specific challenges associated with managing such research projects that risk project failure [46]. URCs tend to have heterogeneous research projects and can present management challenges compared to the activities developed by traditional academic structures [4]. URCs deal with relevant scientific problems, which require multiple skills and the integration of different disciplinary perspectives [47]. Such challenges require in-depth knowledge, and an integrated application of appropriate management approaches, namely, to deal with the wide variety of researchers involved [15], ensure the alignment among the collaborative partners, and generate the required level of impact from the R&D projects [48].

In the context of benefits and challenges of project management, URCs strive to improve PM systems and create PMO structures that can minimise project failure [23,46,49]. Current research into PM emphasises the importance of the PMO as an organisational unit that acts as a repository of learning and knowledge transfer. A PMO, for example, can ensure that project mistakes will not be repeated. In organisations with PMOs, projects

tend to be more focused and visible, facilitating communication between project teams and top management [23].

Table 1 illustrates an overview of the URC themes covered in literature, highlighting the contribution of these works for each of the eight themes identified: characteristics and types of URCs (T1); role of URCs (T2); recommendations for URCs (T3); URCs funding (T4); motivations to engage within URCs (T5); performance/benefits/impacts of URCs (T6); URCs collaboration arrangements (T7); and management arrangements/governance/PMOs (T8). These works allowed the authors to obtain a better knowledge of the URC context, for which the PMO roles and functions have been designed.

Table 1. Overview of the themes covered in URC literature.

Reference	T1	T2	T3	T4	T5	T6	T7	T8
[4]	X				X	X	X	
[5]	X				X	X	X	
[7]		X	X		X	X	X	
[9]			X			X	X	
[10]					X	X		
[15]					X	X		
[16]	X	X		X	X	X	X	
[17]	X				X	X		
[20]	X				X			
[23]								X
[37]	X	X	X	X		X	X	X
[38]			X	X	X	X	X	X
[39]	X	X	X			X	X	
[40]				X		X		
[41]	X					X	X	
[42]						X		X
[43]	X			X			X	X
[44]					X	X		
[45]	X		X		X	X		
[46]						X		X
[47]			X		X	X		X
[48]			X			X		X
[49]						X		X

2.2. Project Management Offices

A PMO structure is a specialised and formal organisational entity that has within its domain several responsibilities related to the management and coordination of projects [50]. These responsibilities may range from providing support functions to direct PM [51]. PMOs started to become more widespread in the mid-1990s, and since then, their number has grown significantly [33,52,53]. The emergence of PMOs is associated with the increasing number and complexity of projects [33]. This significant increase in complexity has generated new challenges for organisations [54].

PMO structures are continually evolving. Fukuyama and Schumpeter's process of creative destruction provides a helpful analogy to describe this phenomenon [55]. Through an economic view of innovation, the authors argue that the capitalist system can be understood as the evolutionary process where firms adapt through creative destruction. Aubry, Hobbs and Thuillier [56] suggest that PMOs adapt to their environment from a contingency perspective, this being a dynamic and intertwined process between strategy and structure [57,58]. There is a bidirectional relationship between the PMO and the organisation in which it operates, i.e., they adapt and evolve together. This process adopts grounded theory as described in Strauss and Corbin [59], where the researcher analyses data to understand a complex social reality through the development of a process [60]. In this approach, the PMO is seen as a temporary state and participates in the development

of the future. This approach has been used to explore the PMO as an organisational innovation [23].

Organisations should be well-advised when deciding to implement a PMO. They should not choose based on mistaken or unfounded assumptions about the value of the money they generate or perceived popularity [61]. Although PMO structures are essential in project-based organisations, the underlying logic that leads to their implementation or renewal is not yet fully understood [62]. Noteworthy, there is no single manual on how to establish and run PMOs in organisations successfully. PMOs are different in size (from single-person departments to entities managing hundreds of people), and there can be just one or several PMOs in various places in the organisation, supporting business, operational or strategic activities [63]. The normative presumptions of longevity, the apparent creation of value, and the descriptions of the generic types of PMOs appear to differ from actual practice, offering neither a solid theory nor a pragmatic orientation to managers [61].

The complexity and variety of PMOs have resulted in various interpretations of what the PMO is and what it should be [64]. Despite this, all definitions have a common feature, i.e., the objective of a PMO is to support PM and increase its effectiveness. The effectiveness of a PMO depends on functions being implemented and their adjustment to organisational needs [65–68]. Therefore, due to each organisation's different structural and contextual dimensions, it is even possible to have different PMOs in structural and functional terms within the same organisation [69].

2.3. Typologies of PMOs

The role and functions of a PMO are subject to various configurations established to ensure the transmission of knowledge and the achievement of goals and objectives [22]. The PMO and the organisation must adapt to the necessary changes to help achieve those goals [66]. PMOs are heterogeneous: they vary in size, function and other aspects [70]. Each organisation should consider what role its PMO plays and adapt it to emerging needs [71]. There is a need to ensure that the roles fit within the organisational and strategic context, increase project performance and meet varying expectations [72]. The challenge for organisations is to reconcile internal PM with governance to align with the organisation's strategic objectives [73]. Therefore, the PMO must adapt to changes that help achieve those strategic goals [66]. Ko and Kim [74] argue that strengthening the project strategic alignments with business goals increases the efficiency and performance of PMOs.

Several characteristics of a PMO were found in the literature. In this study, we identified a total of 55 PMO models comprised of 15 typologies. Typologies found in the literature are presented in Table 2. The most common typology, from which most definitions of typologies originate, comes from the Project Management Institute. The Project Management Book of Knowledge (PMBOK) [51] offers three distinct PMOs with differing levels of authority and control over projects: supportive, controlling, and directive. The PMO can operate as a support unit, providing templates, access to good practices and access to information and lessons learned derived from other projects. It can also control projects, by requiring compatibility of tools and models used within the organisation and standardised PM methodologies and tools. Finally, the PMO can have direct responsibility for all projects and is responsible for overall management.

Table 2. Typologies of PMOs.

Typology	Source
Supportive; Controlling; Directive	[51]
PSO; PMCoE; PgMO	[75]
Project Repository; Project Coaching; Deliver Value Now	[76]
Project Office; Basic PMO; Mature PMO; Enterprise PMO	[77]
Consulting PMO; Knowledge PMO; Standard PMO	[78]
Supporter; Information Manager; Knowledge Manager; Coach	[79]
PSO; PMO; PMCoE; Federated PMO; Enterprise PgMO	[80]
Light; Heavy	[81]
Functional; Customer Group; Corporate/Strategic	[82]
Type 1; Type 2; Type 3	[83]
Supporting; Controlling; Coordinating	[84]
Superordinate; Subordinate; Coequal; Balanced	[70]
Strategic Office; Basic PMO; Standard PMO; Advanced PMO; Centre of Excellence	[85]
Enterprise PMO; Division PMO; Business Unit PMO; Project PMO; Project Office; PSO; PMCoE	[86]
Engineering and Construction; Information Systems and Technology; Business Processes; New Product/Service Development	[87]

Table 2 highlights that several authors have proposed different models and typologies to classify the services offered by a PMO structure. Each typology presents a set of functions that a PMO structure should perform [88,89]. It is beyond the scope of this paper to describe each typology referenced in Table 2. For further information, the reader is encouraged to review the respective references.

The implementation or reconfiguration of a PMO is a necessary organisational evolution. Usually, this change is part of a broader organisational reconfiguration. It requires a methodology and an interpretive framework that can capture the complexity of organisational change [62]. Aubry et al. [56] argue that to understand a PMO, one must consider its context and evolution. For these reasons, the goal of this research was to study the implementation of a PMO structure within the URC context, for which there is limited understanding.

3. Initial Conceptualisation

An initial conceptualisation of PMO structures based on available research literature is proposed. Three types of PMOs are defined based on their maturity: (i) 'basic', (ii) 'intermediate' and (iii) 'advanced'. The conceptualisation focuses on the functions attributed to each type of PMO—emphasising the importance of a contingency approach [90] when pursuing a PMO implementation and highlighting the importance of assessing the relevance of the PMO functions for a particular URC context. Table 3 presents the initial conceptualisation of PMO structures for URCs, i.e., the PMO roles and functions, and key sources or references. The order in which each of these functions appears is not random and should be the starting point for each level. What distinguishes one type from another is the growing importance of the PMO in the URC, a more significant number of responsibilities and the positioning of the PMO in the organisational strategy. All the presented functions have been redefined to clarify and distinguish each function from each other.

Table 3. Initial conceptualisation of PMO structures for URCs.

Role	ID	Functions	Source
Basic	F1	Knowledge management	[33,64,79,91–94]
	F2	Capture and spread project management practices	[79]
	F3	Provide well-trained project managers and teams	[50,64,79,81,91,95]
	F4	Promote social and informal interaction	[64,82]
Intermediate	F5	Develop methodologies	[72,79,95]
	F6	Build a knowledge platform	[72,79,95]
	F7	Provide periodic advice and guidance	[72,79,95]
	F8	Monitor and control project performance	[72,79,95]
	F9	Risk management	[72,79,82,95]
	F10	Support the decision-making process	[72,95]
	F11	Supervision within the organisation	[33,81,96]
Advanced	F12	Strategic management	[25,72,79,82]
	F13	Evaluation and projects selection	[50,72]
	F14	Control and quality assurance	[64]
	F15	Project financial management	[64]
	F16	Close monitor and control of projects	[50]
	F17	Human resource management	[64,70,82,91]
	F18	Project portfolio management	[64,70,91]

4. Research Method

The first phase of this research study consisted of collecting and analysing the relevant literature to identify PMO typologies and functions commonly referenced and their adaptation to the URC context (see Figure 1). This phase resulted in the initial conceptualisation or model. The second phase consisted of conducting a questionnaire survey, which aimed to validate the initial conceptualisation.

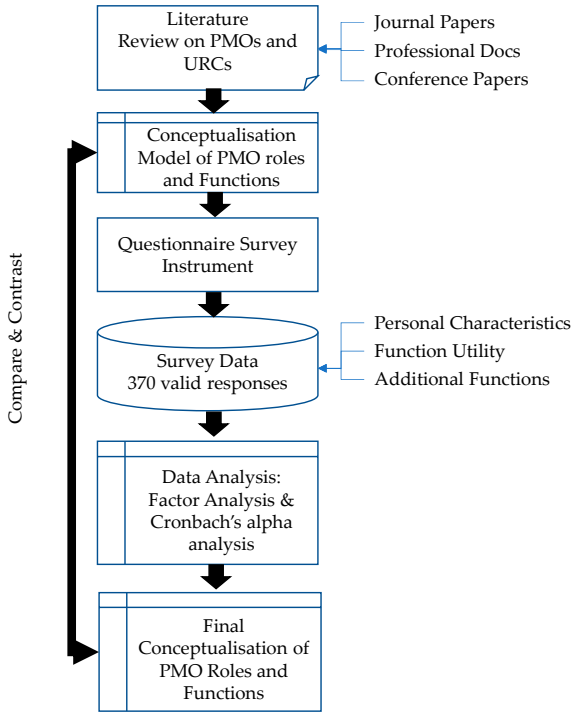

Figure 1. Research method.

4.1. Data Collection

An online questionnaire survey was conducted. Respondents were asked to indicate the utility of the PMO's functions on a 5-point Likert scale, with '5' meaning 'very high' and '1' meaning 'very low'. The questionnaire was divided into three parts, as follows:

- Part A—Characteristics of the respondent. Respondents were asked for information about themselves, their experience and work context (e.g., URC type, scientific area of research projects, roles at URC, experience, age, gender).
- Part B—PMO initial conceptualisation proposed. These questions related to the utility of the identified functions performed by a PMO. There is also an open question where respondents could present any vital function not included in the questionnaire.
- Part C—Questions that served to test the consistency of the answers given in Part B.

The questionnaire was developed by an online survey software tool, LimeSurvey [97], and disseminated online through the e-mail contacts of a selected random sample. A random sample is a sample where the population is uniform or has similar characteristics, and any element of the population has the same probability to be selected [98]. The studied population included researchers associated with the URCs. The selection was made using the websites of URCs in 20 universities. Among those chosen universities, 510 URCs were selected to disseminate the questionnaire. The questionnaire was sent to 18,909 researchers via e-mail and resulted in a 2% response rating, corresponding to 370 completed valid responses.

4.2. Data Analysis

Data were analysed using the SPSS software [99]. The reliability and validity of the data were tested using Cronbach's alpha and factor analysis, respectively. Factor analysis is conducted to explore the relation of the functions within the PMO, i.e., to verify if the questionnaire results led to the aggregation of the functions resultant from the initial conceptualisation. Factor analysis allowed measurable and observable variables to be reduced [100]. It is a primary method to simplify complex data sets [101]. Later, factors were compared with the typology and roles presented in the initial conceptualisation of a PMO.

5. Findings

5.1. The Data Set

Completed survey questionnaires were received from 370 researchers. The respondents were mostly between 30 and 59 years old (77%), 6% were less than 30 years old, 11% were between 60 and 69 years old, and 6% were more than 69 years old. Regarding gender, 61% of the respondents were male, and 39% were female. Concerning the respondents' scientific areas, the most representative areas were 'Exact Sciences and Engineering' and 'Social Sciences and Humanities' with 39% and 32%, respectively, then 'Life and Health Sciences' (14%), 'Natural and Environment Sciences' (7%) and other areas (8%). The primary role that respondents performed in their URC was: 10% 'Director', 3% 'Board Member', 10% 'Line/Research Group Coordinator', 29% 'Senior Research Fellow', 21% 'Research Fellow', 7% 'Research Assistant', 2% 'Administrative' and 18% indicated 'Other role'.

More than a third of respondents (37%) had an implemented PMO or similar structure. However, most respondents (81%) believe that the establishment of a PMO structure would be helpful for their URC, and they were motivated to collaborate within the roles of the PMO structure, which means that they perceived the value of a PMO in the URC to support their research work. For the remaining respondents, only 10% indicated that there is no need to implement a PMO structure, while 9% have no opinion.

5.2. Validity and Reliability Analysis

Before starting the factor analysis, it is necessary to evaluate the factorability of the data collected. For this, it was essential to verify if the correlation of most of the variables is more significant than 0.3. If this happens, it indicates that the data collected is adequate for factor analysis. Then, Bartlett's test of sphericity and a Kaiser–Meyer–Olkin (KMO) measure helped assess the factorability of the data collected. In the KMO test, the KMO index ranges from 0 to 1, and the factorial analysis is assumed appropriate only if KMO is higher than 0.6 for a better indicator of factorability [99–102]. As for Bartlett's test of sphericity, it should be $p < 0.05$ to be significant. After all the test results presented favourable values of factor analysis, the Principal Component Analysis (PCA) was performed. To verify the applicability of the data in this analysis and to be able to proceed with factor analysis, it is necessary to confirm that the communalities have values higher than 0.5 [99]. These results were extracted through the SPSS software package. The next step is determining the number of factors needed to represent the data through the 'factor extraction' [102]. Kaiser's test is one of the most commonly used techniques, also known as the eigenvalue rule [99]. Only the 'factors' with an eigenvalue more significant than one should be considered [102]. The 'varimax rotation' method was performed to simplify the interpretation of the results and to perceive which variables are part of each factor.

Table 4 summarises the factor analysis steps followed in this research and their results. Table 5 presents the varimax rotation and variance explained.

From the results obtained (Table 5), it can be determined that:

- Factor (component) 1: this factor is constituted by ten positively correlated variables: V15, V17, V18, V19, V20, V21, V22, V23, V24 and V25. Therefore, this factor corresponds to the 'advanced' PMO of the initial conceptualisation.
- Factor (component) 2: this factor is constituted by eight variables, all of which strongly correlated positively: V7, V9, V10, V11, V12, V13, V14 and V16. Therefore, this factor corresponds to the 'intermediate' PMO of the initial conceptualisation.
- Factor (component) 3: this factor is constituted by seven variables, all of which strongly correlated positively: V1, V2, V3, V4, V5, V6 and V8. Therefore, this factor corresponds to the 'basic' PMO of the initial conceptualisation.

Once the final structure of all factors is established, it is necessary to conduct reliability analysis using Cronbach's alpha analysis, presented in Table 6. The results obtained are reliable since Cronbach's alpha values are all higher than 0.7 [103].

Table 4. Factor analysis steps followed and their results.

Factor/Component	Cronbach's Alpha
Determine if factor analysis is applicable to data set	All items have at least half of more of their correlation > 0.3 All data is suitable for factor analysis.
	KMO = 0.946 The data set has the 'excellent' level for factor analysis (If KMO > 0.9).
	Bartlett's test of sphericity is significant ($p \approx 0.000$) The data is factorable.
	All items/variables have communalities above 0.5, except V1, V6, V9 and V21, very near the threshold of 0.5 The data shows factorability.
Determine the number of 'factors'	Three 'factors' have an eigenvalue > 1 explaining 62% of the total variance This is a 3-theme construct.
Develop 'factor' structure	Using rotation results, the factor loading matrix was obtained:F1: V15, 17, 18, 19, 20, 21, 22, 23, 24, 25F2: V7, 9, 10, 11, 12, 13, 14, 16F3: V1, 2, 3, 4, 5, 6, 8

Table 5. Rotated component matrix.

Role	Item	ID	PMO Functions	Factor/Component		
				F1	F2	F3
Basic	V1	F1	Develop and manage project portfolio repositories	**0.100**	**0.348**	**0.584**
	V2	F2	Mentor and coach others in the use of good project management practices	**0.319**	**0.237**	**0.679**
	V3	F3	Develop project management competencies through training, workshops, and seminars	**0.137**	**0.340**	**0.683**
	V4	F4	Promote social interaction and stimulate interactions between research communities/groups	**0.436**	**0.024**	**0.648**
	V5	F4	Define and communicate centre and individual projects objectives	**0.483**	**0.024**	**0.648**
Intermediate	V6	F5	Characterise the different types of active R&D projects	**0.118**	**0.367**	**0.483**
	V7	F5	Develop and implement project management methodologies adjusted to each R&D project type	**0.234**	**0.663**	**0.426**
	V8	F6	Create an information platform for all past and ongoing R&D projects	**0.209**	**0.498**	**0.504**
	V9	F6	Provide current and updated information about conferences and potential partners for research	**0.387**	**0.491**	**0.300**
	V10	F6	Implement and manage a 'lessons learned' database	**0.385**	**0.640**	**0.398**
	V11	F7	Support the principal investigators with specific project management tasks	**0.425**	**0.733**	**0.203**
	V12	F8	Provide periodic review reports on the current state of the R&D project	**0.411**	**0.713**	**0.116**
	V13	F9	Implement and manage a risk database associated with different types of R&D projects	**0.315**	**0.572**	**0.394**
	V14	F10	Provide software tools to support creativity, ideation, and project management	**0.146**	**0.654**	**0.322**
	V15	F11	Conduct post-project reviews to ensure the exploitation of the R&D project's results	**0.508**	**0.502**	**0.324**
	V16	F11	Support the development of technical and financial reports	**0.228**	**0.713**	**0.025**
Advanced	V17	F12	Participate in the strategic planning of the research centre	**0.660**	**0.261**	**0.368**
	V18	F13	Identify, select, and prioritise the new ideas for R&D projects	**0.778**	**0.215**	**0.187**
	V19	F14	Assure the quality of the R&D projects through independent assessment	**0.716**	**0.329**	**0.254**
	V20	F15	Manage resource allocation between R&D projects	**0.801**	**0.205**	**0.073**
	V21	F15	Seek funding for new and emerging R&D projects, including networking and lobbying	**0.544**	**0.353**	**0.277**
	V22	F16	Conduct follow-up meetings with each R&D project team to ensure goal alignment	**0.721**	**0.339**	**0.318**
	V23	F17	Manage research capacity by balancing the allocation of human resources to research areas	**0.780**	**0.248**	**0.204**
	V24	F18	Monitor and control the performance of R&D projects and report to the research centre's board	**0.796**	**0.278**	**0.176**
	V25	F18	Manage the exploitation of the results of each R&D project	**0.648**	**0.238**	**0.362**
			Eigenvalues	12.503	1.750	1.325
			Per cent of variance explained	50.01%	6.99%	5.30%

Table 6. Cronbach's alpha analysis.

Factor/Component	Cronbach's Alpha
F1: V15, 17, 18, 19, 20, 21, 22, 23, 24, 25	0.938
F2: V7, 9, 10, 11, 12, 13, 14, 16	0.900
F3: V1, 2, 3, 4, 5, 6, 8	0.830

6. Discussion

After performing factor analysis, the results show only slight differences from the initial conceptualisation that has proven to be very robust. The results do not exclude any of the functions identified in the initial conceptualisation. However, the allocation of the three functions among the types of PMOs varies between 'basic', 'intermediate' and 'advanced' (V6, V8 and V15).

Regarding V6, the highest loading value was 0.483 in Factor 3, identified as the 'basic' PMO. In the initial conceptualisation, this function was assigned to the 'intermediate' PMO. This result makes sense as this function is related to identifying and categorising all the existing projects within the URC. This function should be one of the first initiatives for a PMO to assist the organisation in project classification and prioritisation. Therefore, in the PMO final conceptualisation, this function is moved into the 'basic' PMO.

Regarding V8, the highest loading value was in Factor 3, also related to the 'basic' PMO. In the initial conceptualisation, this function was designed into the 'intermediate' PMO. As Table 5 illustrates, there was a slight difference between the loading values of Factors 2 and 3, respectively, 0.498 and 0.504. Therefore, considering the content of this function, 'Create an information platform for all past and ongoing R&D projects, which requires a high effort to put in place by PMO members, this function was maintained in the 'intermediate' PMO. Additionally, this function also can be seen as an evolution of V6 because, to create a platform with project information, it is necessary to have information related to the characterisation of projects (V6). An 'intermediate' PMO acts as a source of knowledge and a vehicle for enabling knowledge transfer across URC projects from the same or even different categories, facilitating communication between project teams [23–50].

Regarding V15, the highest loading value was in Factor 1, related to the 'advanced' PMO. In the initial conceptualisation, this function was designed into the 'intermediate' PMO. From results analysis, it makes sense that this function should be in the 'advanced' PMO since the guarantee of the exploitation of the project results should be performed by a PMO-experienced team close to the organisation's strategic level. So, for that reason, this function is moved into the 'advanced' PMO. Aligning projects with the organisation's strategic objectives is a major challenge for PMOs [73]; however, strengthening the project strategic alignments with business goals improves the efficiency and performance of PMOs [74]. From a sustainability perspective, the exploitation or post-project phase, and perhaps even the project delivery phase, may bring the expected positive impacts and negative impacts. Therefore the PMO might consider introducing sustainable PM practices into the PM processes [104].

Moreover, 31% of the respondents who answered the open question suggested a new function and responsibility: 'Support the submission of funding applications'. Therefore, this responsibility was placed in the 'intermediate' PMO together with the function 'Support the development of technical and financial reports' (V16). The two functions complement each other since accepted funding applications often require the completion of technical, financial reports later. One of the main motivations for faculty members to join URCs is the access to additional funding [38] to broaden their research agendas; however, these additional resources come also with additional administrative work, such as funding applications and later with regular technical and financial reports, where the PMO can provide important support. Different answers to the open question pointed to functions, such as 'Negotiate the contract with funders and industry' or 'Create a database of potential

funding agencies/calls for funding by research area', only referred to by one respondent not considered in the final conceptualisation.

Therefore, a final conceptualisation of PMO structures for URCs with a total of twenty-six functions is proposed in Figure 2. These are divided into the three PMO typologies and include six for the 'basic' PMO, a further ten for the 'intermediate' PMO, and an additional ten for the 'advanced' PMO. The conceptualisation presents an evolution logic, which means the PMO role might evolve along the time from 'basic' PMO to an 'advanced' PMO.

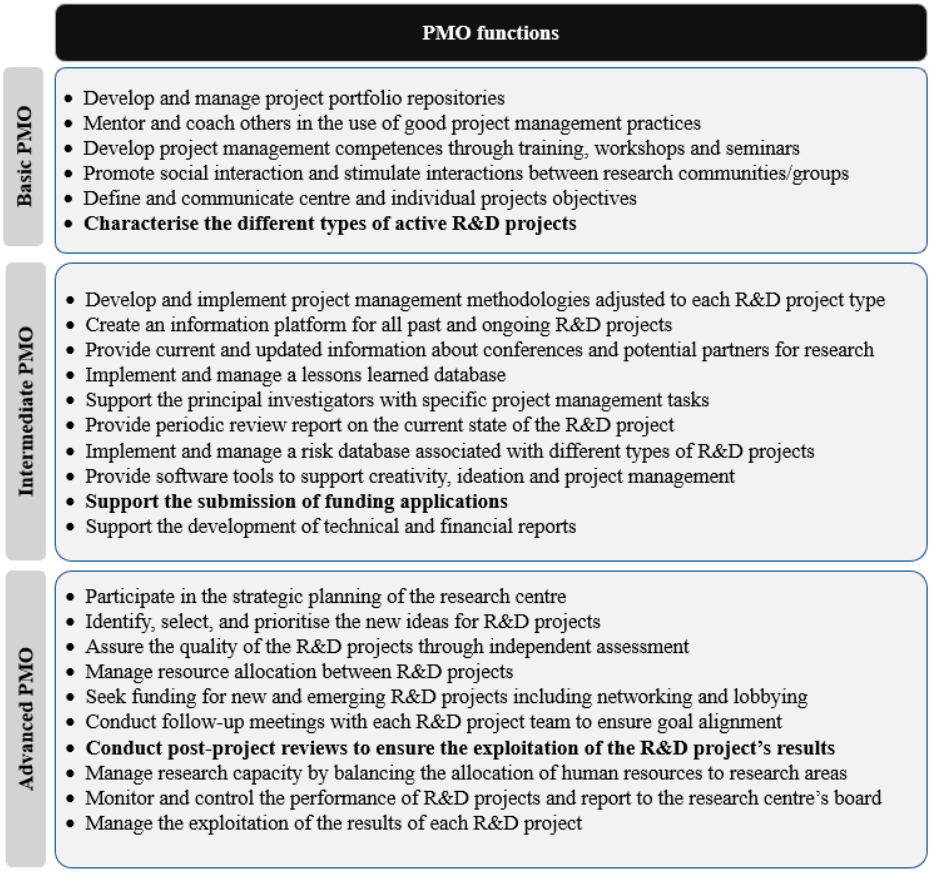

Figure 2. Conceptualisation of PMO structures for URCs.

Besides the gradual implementation of the PMO's functions [105], a PMO structure also depends on some other vital factors:

1. PMO functions' alignment with the URC's culture [62–79] and strategic direction [46]. For example, in the context of a URC, the title of Project Manager is not commonly used since Professors/Researchers associated with URCs with a scientific background typically do not see themselves as managers. URCs might consider naming them Project Leaders.
2. URCs' top management needs to support the PMO implementation [106] and recognise the value of formal and standardised PM practices set by the PMO [52,83,105].
3. Choice of the right leader of the PMO structure and the right PMO team [66–105].
4. Definition of clear communication channels between the PMO structure and the URC top management and project teams [79–83]. The development of communication skills at the individual level is one of the most critical barriers to knowledge transfer [93].

7. Conclusions

This research has focused firstly on the role and functions of PMOs within University Research Centres (URCs) based primarily on previously published literature. Secondly, it reviewed the functions adapted to the URC context, based on the researchers' judgment

and a PMO initial conceptualisation. It then deployed a web-based questionnaire survey where 370 respondents offered their views and experience on the perceived usefulness of the functions identified in the initial conceptualisation. Finally, through factor analysis, this research validated much of the PMO proposed conceptualisation. Twenty-six key functions were presented in URCs, divided by three PMO typologies: 'basic', 'intermediate' and 'advanced' (see Figure 2).

The questionnaire results also show that respondents perceived the value of a PMO and that URC members are receptive to creating a PMO in their own context. As Artto et al. [50] discussed, the PMO can have an integrative role in the front end of innovation and contribute to the overall organisational performance discussed by Aubry and Hobbs [107]. More recently, Sergeeva and Ali [34] demonstrated that PMOs play an essential role in integrating innovation, exploration and exploitation throughout the project life cycle. Project managers, commonly named Principal Investigators in URC organisations, are excellent researchers but less skilled or interested in PM [35]. Therefore, PMO structures can play a critical role in the URC context.

The research reported in this paper develops new knowledge in the domain of PMOs in the context of URCs, for which there is currently limited understanding. This study identifies the primary roles and functions of a PMO to support URCs. Moreover, it provides empirical evidence on the evolutionary perspective of the implementation of PMOs within organisations.

7.1. Management Implications

This research study provides guidance and decision support to URCs when selecting the role that a PMO should play for achieving tangible and intangible benefits of their projects and programs. It provides important managerial insights by indicating some of the competencies, usually outsourced by URCs to management consultancies, that might be performed instead by an internal structure such as a PMO. By contrast, Martins and Martins [108] explore the mechanisms that influence decisions regarding outsourcing competencies in the operation of PMOs.

PMO structures support the implementation of PM practices that would help to maximise project and program benefits, and to increase the transparency of information transfer among research partners [65]. The PMO promotes trust, which in turn contributes to reducing the effect of different and sometimes competing expected benefits from research partners [109]. The PMO plays a significant role in embedding PM practices, particularly where there is a high interdependence between partners [110]. Moreover, the PMO acts as a repository of learning and a vehicle for enabling knowledge transfer across URC projects, thereby achieving greater project synergies [23–50].

PMOs have an important contribution to project start-up, execution, and societal impact by establishing a pseudo-independent unit focused on strategy, ideation, project management, project portfolio management, and enhancing societal impact. Establishing a PMO is not without costs, but the benefits are clear both from this research and literature in the field. The costs for a PMO can be offset by the overhead contribution now common within all major research projects and programs. PMOs can enhance learning around the development and execution of complex programs, improve communications, and perhaps most importantly, ensure that quality and risks are managed and that societal impact is assured in addition to scientific impact.

7.2. Limitations and Future Research

The existence of few studies on PMO structures from the perspective of URC organisations was the main difficulty faced by the researchers. Almost all of the literature analysed refers to the implementation of PMOs in an exclusively business context. The relatively low response rate (2%) to the questionnaire survey might be seen as a research limitation; however, this is offset by the high number of respondent participants (370).

Although the study suggests a lengthy list of ordered pertinent functions for URCs, none of these should be considered isolated variables. Most of the functions interact with each other and affect the PMOs' potential impact within the URC. Therefore, further research can be performed by applying the findings of this study towards the understanding of the roles of PMOs and the weight that different URCs place on various functions and how they interact, highlighting the URC contextual variables. It would also be helpful to develop a model to assess the effectiveness and efficiency of PMOs in URCs since the PM value for the particular context of R&D projects [71] has been questioned by several scholars [111,112].

Author Contributions: The four authors collaborated to produce this paper. G.F., as the principal researcher, designed and conducted the research in the field; H.S. supported the collection process of data; A.T. and D.O. provided guidance and support for the fieldwork and the development of the conceptualisation of PMO structures for URCs. The four authors contributed to the analysis and interpretation of the results. All authors have read and agreed to the published version of the manuscript.

Funding: This work has been supported by national funds through the FCT—Fundação para a Ciência e Tecnologia, within the R&D Units Projects UIDB/00285/2020 and UIDB/00319/2020.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ferreira, J.J.; Teixeira, A.A.C. Open innovation and knowledge for fostering business ecosystems. *J. Innov. Knowl.* **2019**, *4*, 253–255. [CrossRef]
2. Perkmann, M.; Salandra, R.; Tartari, V.; McKelvey, M.; Hughes, A. Academic engagement: A review of the literature 2011-2019. *Res. Policy* **2021**, *50*, 104114. [CrossRef]
3. Berbegal-Mirabent, J.; Sánchez García, J.L.; Ribeiro-Soriano, D.E. University–industry partnerships for the provision of R&D services. *J. Bus. Res.* **2015**, *68*, 1407–1413. [CrossRef]
4. Moutinho, J.d.A.; Junior, R.R. Centro de pesquisa universitária: Caracterização do ambiente de pesquisa. *Cad. EBAPE. BR* **2020**, in press.
5. Bozeman, B.; Boardman, C. *Managing the New Multipurpose, Multidiscipline University Research Centers: Institutional Innovation in the Academic Community*; IBM Center for the Business of Government: Washington, DC, USA, 2003.
6. Etzkowitz, H.; Kemelgor, C. The Role of Research Centres in the Collectivisation of Academic Science. *Minerva* **1998**, *36*, 271–288. [CrossRef]
7. Stahler, G.; Tash, W. Centers and institutes in the reserach university: Issues, problems and prospects. *J. High. Educ.* **1994**, *65*, 540–554. [CrossRef]
8. Sabharwal, M.; Hu, Q. Participation in university-based research centers: Is it helping or hurting researchers? *Res. Policy* **2013**, *42*, 1301–1311. [CrossRef]
9. Boardman, C.; Corley, E. University research centers and the composition of research collaborations. *Res. Policy* **2008**, *37*, 900–913. [CrossRef]
10. Bunton, S.; Mallon, W. The Impact of Centers and Institutes on Faculty Life: Findings from a Study of Life Sciences Faculty at Research-Intensive Universities' Medical Schools. *Innov. High. Educ.* **2007**, *32*, 93–103. [CrossRef]
11. Corley, E.; Gaughan, M. Scientists' Participation in University Research Centers: What are the Gender Differences? *J. Technol. Transf.* **2005**, *30*, 371–381. [CrossRef]
12. Ponomariov, B.; Boardman, C. Influencing scientists' collaboration and productivity patterns through new institutions: University research centers and scientific and technical human capital. *Res. Policy* **2010**, *39*, 613–624. [CrossRef]
13. Bozeman, B.; Corley, E. Scientists' collaboration strategies: Implications for scientific and technical human capital. *Res. Policy* **2004**, *33*, 599–616. [CrossRef]
14. Gaughan, M.; Ponomariov, B. Faculty publication productivity, collaboration, and grants velocity: Using curricula vitae to compare center-affiliated and unaffiliated scientists. *Res. Eval.* **2008**, *17*, 103–110. [CrossRef]
15. Gaughan, M.; Corley, E. Technovation Science faculty at U.S. research universities: The impacts of university research center-affiliation and gender on industrial activities. *Technovation* **2010**, *30*, 215–222. [CrossRef]
16. Rogers, E.; Hall, B.; Steffensen, M.; Speakman, K.; Timko, M. Technology Transfer from University-Based Research Centers. *J. High. Educ.* **1999**, *70*, 687–705. [CrossRef]

17. Youtie, J.; Libaers, D.; Bozeman, B. Institutionalization of university research centers: The case of the National Cooperative Program in Infertility Research. *Technovation* **2006**, *26*, 1055–1063. [CrossRef]
18. Kleinman, D.; Vallas, S. Science, Capitalism, and the Rise of the "Knowledge Worker": The Changing Structure of Knowledge Production in the United States. *Theory Soc.* **2001**, *30*, 451–492. Available online: http://www.jstor.org/stable/658124 (accessed on 2 July 2019). [CrossRef]
19. Slaughter, S.; Campbell, T.; Holleman, M.; Morgan, E. The "Traffic" in Graduate Students: Graduate Students as Tokens of Exchange between Academe and Industry. *Sci. Technol. Hum. Values* **2002**, *27*, 282–312. [CrossRef]
20. Boardman, C.; Bozeman, B. Role Strain in University Research Centers. *J. High. Educ.* **2007**, *78*, 430–463. [CrossRef]
21. Boardman, C.; Ponomariov, B. Reward Systems and NSF University Research Centers: The Impact of Tenure on University Scientists' Valuation of Applied and Commercially Relevant Research. *J. High. Educ.* **2007**, *78*, 51–70. [CrossRef]
22. Aubry, M.; Hobbs, B.; Thuillier, D. A new framework for understanding organisational project management through the PMO. *Int. J. Proj. Manag.* **2007**, *25*, 328–336. [CrossRef]
23. Hobbs, B.; Aubry, M.; Thuillier, D. The project management office as an organisational innovation. *Int. J. Proj. Manag.* **2008**, *26*, 547–555. [CrossRef]
24. Aubry, M.; Hobbs, B.; Thuillier, D. The contribution of the project management office to organisational performance. *Int. J. Manag. Proj. Bus.* **2009**, *2*, 141–148. [CrossRef]
25. Phan, J. Using the project management office to connect the dots between projects and strategy. *Healthc. Manag. Forum* **2015**, *28*, 65–68. [CrossRef]
26. Project Management Institute. The Impact of PMOs on Strategy Implementation. *Proj. Manag. Inst.* **2013**, 1–18.
27. Aubry, M.; Hobbs, B.; Müller, R.; Blomquist, T. Identifying Forces Driving PMO Changes. *Proj. Manag. J.* **2010**, *41*, 30–45. [CrossRef]
28. Tsaturyan, T.; Müller, R. Integration and governance of multiple project management offices (PMOs) at large organizations. *Int. J. Proj. Manag.* **2015**, *33*, 1098–1110. [CrossRef]
29. Hodgson, D.E.; Cicmil, S. *Making Projects Critical*; Palgrave Macmillan: London, UK, 2006; p. 361.
30. Turner, J.R. *The Handbook of Project-Based Management: Improving the Processes for Achieving Strategic Objectives*; McGraw-Hill: New York, NY, USA, 1999; p. 529.
31. Wedekind, G.; Philbin, S. Research and Grant Management: The Role of the Project Management Office (PMO) in a European Research Consortium Context. *SRA J.* **2018**, *49*, 43–62.
32. Lee-Kelley, L.; Turner, N. PMO managers' self-determined participation in a purposeful virtual community-of-practice. *Int. J. Proj. Manag.* **2017**, *35*, 64–77. [CrossRef]
33. Pellegrinelli, S.; Garagna, L. Towards a conceptualisation of PMOs as agents and subjects of change and renewal. *Int. J. Proj. Manag.* **2009**, *27*, 649–656. [CrossRef]
34. Sergeeva, N.; Ali, S. The Role of the Project Management Office (PMO) in Stimulating Innovation in Projects Initiated by Owner and Operator Organizations. *Proj. Manag. J.* **2020**, *51*, 440–451. [CrossRef]
35. Widforss, G.; Rosqvist, M. The Project Office as Project Management Support in Complex Environments. *Procedia Comput. Sci.* **2015**, *64*, 764–770. [CrossRef]
36. Fundação para a Ciência e Tecnologia. 2019. Available online: http://www.fct.pt/apoios/unidades/unidadesid (accessed on 13 July 2019).
37. Lal, B.; Boardman, C.; Link, J.; Shipp, S. *Designing the Next Generation of NSF Engineering Research Centers: Insights from Worldwide Practice*; Science and Technology Policy Institute: Washington, DC, USA, 2007.
38. Mallon, W. The Benefits and Challenges of Research Centers and Institutes in Academic Medicine: Findings from Six Universities and Their Medical Schools. *Acad. Med.* **2006**, *81*, 502–512. [CrossRef] [PubMed]
39. Ikenberry, S.; Friedman, R. *Beyond Academic Departments: The Story of Institutes and Centers*; Jossey-Bass: San Francisco, CA, USA, 1972.
40. Gaughan, M.; Bozeman, B. Using curriculum vitae to compare some impacts of NSF research grants with research Center funding. *Res. Eval.* **2002**, *11*, 17–26. [CrossRef]
41. Torres Zapata, I. University Research Centres: Organizational Structures and Performance. *J. Technol. Manag. Innov.* **2019**, *14*, 23–43. [CrossRef]
42. Magro, E.; Wilson, J.R. Complex innovation policy systems: Towards an evaluation mix. *Res. Policy* **2013**, *42*, 1647–1656. [CrossRef]
43. Sá, C. University-Based Research Centers: Characteristics, Organization, and Administrative Implications. *J. Res. Adm.* **2008**, *39*, 32–40.
44. Nursall, A. Building public knowledge: Collaborations between science centres, universities and industry. *Int. J. Technol. Manag. Int J. Technol Manage* **2003**, *25*. [CrossRef]
45. Wen, J.; Kobayashi, S. Exploring collaborative R&D network: Some new evidence in Japan. *Res. Policy* **2001**, *30*, 1309–1319. [CrossRef]
46. Philbin, S.P.; Kaur, R. Measuring PMO Performance—Application of the Balanced Scorecard in a Collaborative Research Context. *J. Mod. Proj. Manag.* **2020**, *7*. [CrossRef]
47. Carayannis, E.; Del Giudice, M.; Rosaria Della Peruta, M. Managing the intellectual capital within government-university-industry R&D partnerships. *J. Intellect. Cap.* **2014**, *15*, 611–630. [CrossRef]

48. Philbin, S. PMO Implementation for Project Management in a Collaborative Research Context. In Proceedings of the 39th American Society for Engineering Management (ASEM) International Annual Conference, Coeur d'Alene, ID, USA, 17–20 October 2018.
49. Kutsch, E.; Ward, J.; Hall, M.; Algar, J. The Contribution of the Project Management Office: A Balanced Scorecard Perspective. *Inf. Syst. Manag.* **2015**, *32*, 105–118. [CrossRef]
50. Artto, K.; Kulvik, I.; Poskela, J.; Turkulainen, V. The integrative role of the project management office in the front end of innovation. *Int. J. Proj. Manag.* **2011**, *29*, 408–421. [CrossRef]
51. PMI. *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 6th ed.; Project Management Institute: Newtown Square, PA, USA, 2017.
52. Kerzner, H. *Project Management Best Practices: Achieving Global Excellence*, 4th ed.; John Wiley & Sons, Inc.: New York, NY, USA, 2018; p. 784.
53. Spelta, A.G.; Albertin, A.L. Project Management Offices in the IT Area: A Context–Discriminant Model for their Establishment. *Inf. Syst. Manag.* **2012**, *29*, 40–54. [CrossRef]
54. Spalek, S. Do You Really Want Your Project Management Office to Survive? In Proceedings of the Project Management Institute Global Congress, Newtown Square, PA, USA, 26–28 October 2014.
55. Fukuyama, F.; Schumpeter, J.A. Capitalism, Socialism and Democracy. *Foreign Aff.* **1997**, *76*, 214. [CrossRef]
56. Aubry, M.; Hobbs, B.; Thuillier, D. Organisational project management: An historical approach to the study of PMOs. *Int. J. Proj. Manag.* **2008**, *26*, 38–43. [CrossRef]
57. Chandler, A.D. *Strategy and Structure: Chapters in the History of the Industrial Enterprise*; MIT Press: Cambridge, MA, USA, 1990; p. 463.
58. Pettigrew, A.M. *Innovative Forms of Organizing: International Perspectives*; Sage Publications: Washington, DC, USA, 2003; p. 411.
59. Strauss, A.; Corbin, J. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*; Sage Publications: Washington, DC, USA, 1990; p. 270.
60. Langley, A. Strategies for Theorizing from Process Data. *Acad. Manag. Rev.* **1999**, *24*, 691–710. [CrossRef]
61. Brian, H.; Aubry, M. A Multi-Phase Research Program Investigating Project Management Offices (PMOs): The results of Phase 1. *Proj. Manag. J.* **2007**, *38*, 74–86. [CrossRef]
62. Aubry, M.; Müller, R.; Hobbs, B.; Blomquist, T. Project management offices in transition. *Int. J. Proj. Manag.* **2010**, *28*, 766–778. [CrossRef]
63. Spalek, S.; Kuhn, T.; Dayton, S. Real-life examples of how to ensure PMO alignment with organisational needs. In Proceedings of the PMI Global Congress—EMEA, Barcelona, Spain, 9–11May 2016.
64. Pemsel, S.; Wiewiora, A. Project management office a knowledge broker in project-based organisations. *Int. J. Proj. Manag.* **2013**, *31*, 31–42. [CrossRef]
65. Fernandes, G.; Bacelar Pinto, E.; Araújo, M.; Machado, R.-J. The roles of a Programme and Project Management Office to support collaborative university–industry R&D. *Total Qual. Manag. Bus. Excell.* **2018**, *31*, 1–26. [CrossRef]
66. Hurt, M.; Thomas, J.L. Building Value Through Sustainable Project Management Offices. *Proj. Manag. J.* **2009**, *40*, 55–72. [CrossRef]
67. Pansini, F.; Terzieva, M. Challenges and Benefits on the Path towards Discovering PMO: Cases from Italian Banking Sector. *Procedia Technol.* **2013**, *9*, 627–637. [CrossRef]
68. Pinto, A.; Cota, M.F.; Levin, G. The PMO Maturity Cube, a Project Management Office Maturity Model. In Proceedings of the PMI Research and Education Congress, Washington, DC, USA, 14 July 2010.
69. Jalal, M.; Koosha, S. Identifying organizational variables affecting project management office characteristics and analyzing their correlations in the Iranian project-oriented organizations of the construction industry. *Int. J. Proj. Manag.* **2015**, *33*, 458–466. [CrossRef]
70. Müller, R.; Glückler, J.; Aubry, M. A Relational Typology of Project Management Offices. *Proj. Manag. J.* **2013**, *44*, 59–76. [CrossRef]
71. Fernandes, G.; O'Sullivan, D.; Pinto, E.B.; Araújo, M.; Machado, R.J. Value of project management in university–industry R&D collaborations. *Int. J. Manag. Proj. Bus.* **2020**, *13*, 819–843. [CrossRef]
72. Cunha, J.A.; Moura, H. Project Management Office: The State of the Art Based on a Systematic Review. In Proceedings of the 10th European Conference on Management, Leadership and Governance (ECMLG), Zagreb, Croatia, 13–14 November 2014; pp. 41–49.
73. Too, E.G.; Weaver, P. The management of project management: A conceptual framework for project governance. *Int. J. Proj. Manag.* **2014**, *32*, 1382–1394. [CrossRef]
74. Ko, J.H.; Kim, D. The Effects of Maturity of Project Portfolio Management and Business Alignment on PMO Efficiency. *Sustainability* **2019**, *11*, 238. [CrossRef]
75. Englund, R.L.; Graham, R.J.; Dinsmore, P.C. *Creating the Project Office: A Manager's Guide to Leading organizational Change*; John Wiley & Sons Inc.: New York, NY, USA, 2003; p. 336.
76. Kendall, G.I.; Rollins, S.C. *Advanced Project Portfolio Management and the PMO: Multiplying ROI at Warp Speed*; J. Ross Publishing: Plantation, FL, USA, 2003; p. 448.
77. Garfein, S.J. Strategic portfolio management: A smart, realistic and relatively fast way to gain sustainable competitive advantage. In Proceedings of the PMI®Global Congress 2005—North America, Toronto, ON, Canada, 10–13 September 2005.
78. Letavec, C.J. *The Program. Management Office: Establishing, Managing and Growing the Value of a PMO*; J. Ross Publishing: Plantation, FL, USA, 2006.

79. Desouza, K.C.; Evaristo, J.R. Project management offices: A case of knowledge-based archetypes. *Int. J. Inf. Manag.* **2006**, *26*, 414–423. [CrossRef]
80. Gartner Research, G. *PMOs: One Size Does Not Fit All*; Gartner: Stamford, CT, USA, 2008.
81. Singh, R.; Keil, M.; Kasi, V. Identifying and overcoming the challenges of implementing a project management office. *Eur. J. Inf. Syst.* **2009**, *18*, 409–427. [CrossRef]
82. Kerzner, H. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*; John Wiley & Sons, Inc.: New Jersey, 2009.
83. Crawford, J.K. *The Strategic Project Office*, 2nd ed.; CRC Press, Inc.: Boca Raton, FL, USA, 2010; p. 343.
84. Unger, B.N.; Gemünden, H.G.; Aubry, M. The three roles of a project portfolio management office: Their impact on portfolio management execution and success. *Int. J. Proj. Manag.* **2012**, *30*, 608–620. [CrossRef]
85. Hill, G.M. *The Complete Project Management Office Handbook*, 3rd ed.; Auerbach Publications: New York, NY, USA, 2013; p. 677.
86. Hubbard, D.G.; Bolles, D.L. PMO Framework and PMO Models for Project Business Management. *PM World J.* **2015**, *4*, 22.
87. Aubry, M.; Brunet, M. Organizational Design in Public Administration: Categorization of Project Management Offices. *Proj. Manag. J.* **2016**, *47*, 107–129. [CrossRef]
88. Monteiro, A.; Santos, V.; Varajão, J. Project Management Office Models—A Review. *Procedia Comput. Sci.* **2016**, *100*, 1085–1094. [CrossRef]
89. Pansini, F.; Terzieva, M.; Morabito, V. The path towards discovering PMO: An exploratory analysis of the Italian banking sector. *Int. J. Inf. Syst. Proj. Manag.* **2014**, *2*, 27–40. [CrossRef]
90. Hanisch, B.; Wald, A. A Bibliometric View on the Use of Contingency Theory in Project Management Research. *Proj. Manag. J.* **2012**, *43*, 4–23. [CrossRef]
91. Dai, C.X.; Wells, W.G. An exploration of project management office features and their relationship to project performance. *Int. J. Proj. Manag.* **2004**, *22*, 523–532. [CrossRef]
92. Eriksson, P.E.; Leiringer, R. Explorative and exploitative learning in project-based organizations: Improving knowledge governance through a project management office? *Eng. Proj. Organ. J.* **2015**, *5*, 160–179. [CrossRef]
93. Martinez Sanz, M.M.; Ortiz-Marcos, I. Dimensions of knowledge governance in a multi-PMO project context. *Int. J. Manag. Proj. Bus.* **2019**, *13*, 1423–1441. [CrossRef]
94. Winter, M.; Smith, C.; Morris, P.; Cicmil, S. Directions for future research in project management: The main findings of a U.K. government-funded research network. *Int. J. Proj. Manag.* **2006**, *24*, 638–649. [CrossRef]
95. Kwak, Y.; Dai, C. Assessing the Value of Project Management Offices (Pmo). *PMI Res. Conf.* **2000**, 1–8.
96. Ward, J.; Daniel, E. The role of project management offices (PMOs) in I.S. project success and management satisfaction. *J. Enterp. Inf. Manag.* **2013**, *26*, 316–336. [CrossRef]
97. LimeSurvey. *LimeSurvey: The Online Survey Tool—Open Source Surveys*; LimeSurvey, 2019.
98. Walliman, N.; Baiche, B. *Your Research Project: A Step-by-Step Guide for the First-Time Researcher*; Sage Publications: Washington, DC, USA, 2001.
99. Field, A. *Discovering Statistics Using IBM SPSS Statistics*; Sage Publications: Washington, DC, USA, 2017; p. 1104.
100. Bartholomew, D.; Knott, M.; Moustaki, I. *Latent Variable Models and Factor Analysis: A Unified Approach*; John Wiley & Sons: New York, NY, USA, 2011.
101. Decoster, J.; Hall, G.P. Overview of Factor Analysis. *PRACT* **1998**, *37*, 141. [CrossRef]
102. Kim, J.-O.; Mueller, C.W. *Factor Analysis: Statistical Methods and Practical Issues*; Sage Publications, Inc.: Washington, DC, USA, 1978; p. 88.
103. Nunnally, J.C.; Bernstein, I.H. *Psychometric Theory*, 3rd ed.; McGraw-Hill: New York, NY, USA, 1994.
104. Armenia, S.; Dangelico, R.M.; Nonino, F.; Pompei, A. Sustainable Project Management: A Conceptualisation-Oriented Review and a Framework Proposal for Future Studies. *Sustainability* **2019**, *11*, 2664. [CrossRef]
105. Andersen, B.; Henriksen, B.; Aarseth, W. Benchmarking of Project Management Office Establishment: Extracting Best Practices. *J. Manag. Eng.* **2007**, *23*, 97–104. [CrossRef]
106. Spalek, S. Improving industrial engineering performance through a successful project management office. *Eng. Econ.* **2013**, *24*, 88–98. [CrossRef]
107. Aubry, M.; Hobbs, B. A Fresh Look at the Contribution of Project Management to Organizational Performance. *Proj. Manag. J.* **2011**, *42*, 3–16. [CrossRef]
108. Martins, V.A.; Martins, M.R. Outsourcing Operations in Project Management Offices: The Reality of Brazilian Companies. *Proj. Manag. J.* **2012**, *43*, 68–83. [CrossRef]
109. Fernandes, G.; O'Sullivan, D. Benefits Management in University-Industry Collaboration Programs. *International J. Proj. Manag.* **2021**, *39*, 71–84. [CrossRef]
110. Morandi, V. The management of industry–university joint research projects: How do partners coordinate and control R&D activities? *J. Technol. Transf.* **2013**, *38*, 69–79. [CrossRef]
111. Benner, M.J.; Tushman, M.L. Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited. *Acad. Manag. Rev.* **2003**, *28*, 238–256. [CrossRef]
112. Du, J.; Leten, B.; Vanhaverbeke, W. Managing open innovation projects with science-based and market-based partners. *Res. Policy* **2014**, *43*, 828–840. [CrossRef]