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Empirical Research Paper

Overcoming the 'use misfit' of project management practices in collaborative research, development and innovation

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ABSTRACT

This paper aims to enhance our understanding of project management (PM) in collaborative Research & Development & Innovation (R&D&I) projects by analysing the fit between the use and usefulness of 35 PM practices. Research results include quantitative data analysis of 465 responses to an online survey questionnaire, complemented by a qualitative data analysis of 12 semi-structured interviews. The study identifies the top-10 'most used' and 'most useful' PM practices in collaborative R&D&I, covering the complete PM lifecycle while emphasising the importance of the project 'Initiation' phase. Furthermore, it identifies a set of 'must have' PM practices that exhibit a perfect fit, suggesting that consistent implementation impacts successful project outcomes. The remaining 26 PM practices surveyed present a 'use misfit', meaning they are deemed useful but are not frequently used. The paper delves into the causes behind this and explores potential strategies to address it, with leadership emerging as a significant strategy to overcome practice misfits.

1. Introduction

Rapid technology change and increased global competition are two of the many challenges facing private (e.g., industry) and public (e.g., university) organisations. The recurring answer to these challenges is more innovation (Adner and Kapoor, 2010; Song et al., 2022) and, in particular, collaborative or open innovation that can increase novelty. Businesses find it challenging to achieve novel innovation by relying exclusively on their R&D&I capabilities and resources (Rocha et al., 2022). This is mainly due to the complexity of new technologies and the necessary complementary resources to develop novel and sustainable innovation (Bae and Lee, 2020; Choi, 2019).

Over recent decades, there has been a global movement towards encouraging more collaboration between universities and private organisations or University-Industry Collaborations (UIC) (Barnes et al., 2002). UICs generate multiple benefits (Barnes et al. (2002), including enhancing national competitiveness and wealth creation since they can potentially yield outputs that are valuable for all collaborators (Song et al., 2022). Many authors have also highlighted UIC's importance in improving innovation capabilities (Barnes et al., 2002; Fernandes and O'Sullivan, 2021; Huang and Chen, 2017; Rohrbeck and Arnold, 2006).

As UICs become more popular, many forms have emerged, with the most common focus being on collaborative R&D&I projects. UICs are temporary organisations with heterogeneous partners who have collective responsibilities and, in most cases, public funding support (Fernandes and O'Sullivan, 2023). Universities and industries work together with the principal objective of generating new knowledge (Butcher and Jeffrey, 2005; Petruzzelli, 2011), with the former organisations playing an explorative role while the latter acts more as exploitative facilitators (O'dwyer et al., 2022; Petruzzelli, 2011). These roles may be interchangeable in fulfilling a set of agreed project goals (Brocke and Lippe, 2015; Nsanzumuhire and Groot, 2020).

Even though collaborative R&D&I projects have become more frequent, many still fail (Anantatmula and Rad, 2018; Barnes et al., 2006). Collaborative R&D&I projects have their particularities, such as shared responsibilities, heterogeneity of partners, conflicting stakeholders' expectations and barriers, mainly related to trust and knowledge sharing (Brocke and Lippe, 2015; Fernandes and O'Sullivan, 2021;

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O'dwyer et al., 2022). The management and governance of collaborative R&D&I projects are usually influenced by various characteristics, challenges and barriers (Besner and Hobbs, 2012, 2013). Current research literature appears too fragmented to help identify appropriate approaches for effectively managing Collaborative R&D&I projects (Ankrah and AL-Tabbaa, 2015; König et al., 2013; Perkmann et al., 2013) and new methodologies and approaches are required to manage them successfully (Fernandes and O'Sullivan, 2023).

The field of collaborative R&D&I project management (PM) remains understudied (Wang et al., 2021), despite the discipline of PM being a critical success factor for all kinds of projects (Simões et al., 2021). In the context of collaborative R&D&I projects, PM can mitigate or even solve most of the issues associated with cultural and organisational differences between universities and industry (Barnes et al., 2006). Although most literature regarding collaborative R&D&I PM focuses on a macro-level implementation, this paper aims to emphasise micro-level implementations. Micro-level practices are defined in this research as the tools and techniques by which PM processes are delivered and supported. In other words, they are the mechanisms project managers and project team members use to help with PM execution (Barbosa et al., 2021; Besner and Hobbs, 2006; Fernandes and O'Sullivan, 2023).

Using the Practice-Based View theory (Bromiley and Rau, 2014), this paper aims to examine 35 PM practices known for their effectiveness to assess how well they are being used and whether they are useful in practice. The analysis will focus on the fit of these practices, i.e., whether practitioners perceive them as useful and use them accordingly. The research was conducted in two steps, the first concerning a quantitative data collection through an online survey questionnaire, in which we answered the research question: *What PM practices present a misfit between their use and usefulness?* Then, qualitative data was collected through semi-structured interviews to answer the following research questions: *What are the causes for the misfit?* And *what strategies can be implemented to mitigate the misfit?*

With this mixed research methodology, it was possible to explore the 'most used' and 'most useful' PM practices in collaborative R&D&I projects, and determine how well their use fitted with their perceived usefulness. Additionally, for those practices that presented a misfit, the causes and potential strategies for overcoming them are explored.

This research contributes to the literature by enhancing our understanding of collaborative R&D&I PM practices. By studying the fit between the use and usefulness in temporary inter-organisational contexts, our research provides an innovative set of PM practices that present a fit between their use and usefulness and are understood as 'must have' PM practices to manage collaborative R&D&I projects successfully. Additionally, the study identifies 26 key PM practices for project success and innovation with a 'use misfit' as well as the main reasons why this occurred and the proposed strategies for closing the gap between the use and usefulness of PM practices in a temporary inter-organisational environment. This highlights the key role of leadership in this process.

This paper begins with a review of the research literature on PM practices in collaborative R&D&I projects. This is followed by an explanation of the research methodology and the steps taken to collect and analyse quantitative and qualitative primary data. The main findings emerging from the study are discussed, followed by conclusions and empirical propositions for future work.

2. Literature review

In this section, we detail the main characteristics and challenges of collaborative R&D&I and its benefits. This is followed by a review of the relevance of PM implementation, focusing on PM practices, their use misfit, and their relationship with leadership.

2.1. Collaborative R&D&I projects

Governments have increasingly promoted collaborative R&D&I projects (Bae and Lee, 2020) — a form of a temporary inter-organisational collaboration. Private organisations are now more prone to collaborate with Higher Education Institutions (HEIs) (Keinz et al., 2021) since collaborative R&D&I projects are recognised as a solution for problems that neither HEIs nor firms can solve by themselves (Salter and Martin, 2001). Collaborative R&D&I projects are the key to developing new technologies, products, and services (Faria et al., 2020) since they offer organisations the opportunity to share and diversify resources (Faccin and Balestrin, 2018), mitigate risks, and acquire complementary skills (Barnes et al., 2002; Calamel et al., 2012). These skills are essential to deal with high risk and uncertainty and the demand for innovation and creativity (Fernandes and O'Sullivan, 2023; König et al., 2013; Perkmann et al., 2013; Song et al., 2022).

The heterogeneity of collaborating partners is mainly positive, such as the provision of complementary resources and skills (Canhoto et al., 2016), especially those with different knowledge backgrounds (Song et al., 2022). Complementary skills facilitate the collaborative consortium to pivot from existing knowledge to develop new products, services and processes with effectiveness and efficiency (Keinz et al., 2021). However, it also brings some cultural differences, often called 'cultural gap' (Barnes et al., 2002, 2006). These differences increase the ambidexterity of collaborative R&D&I projects since HEIs and firms have different working processes and contrasting expectations (Brocke and Lippe, 2015; Rohrbeck and Arnold, 2006).

In addition to HEIs and industry also having different working methods, they also have contrasting priorities regarding, for example, time availability. HEIs often require more extended periods to develop their projects, whereas industries are usually pressured by short product and economic cycles (Ivascu et al., 2016; Pertuze, 2010). Also, while industry partners prefer to keep the R&D&I results in-house, HEI partners often need to publish research results publicly in scientific papers to increase their prestige further (Rohrbeck and Arnold, 2006).

Communication and trust issues are also associated with the heterogeneity of partnerships. In the early stages of collaboration, trust is a common barrier which leads to partners being reluctant to share any knowledge or resources because they are afraid of any leakage of intellectual assets (O'Dwyer et al., 2022). Thus, effective communication enhances trust and strengthens partner relationships (Chin et al., 2011). A strategy to improve trust among partners includes promoting regular meetings for information exchange and joint work on the project (Bürger and Roijakkers, 2021). Developing sound and continuous communication channels fosters trust, which can help mitigate cultural differences (Nsanzumuhire and Groot, 2020). The choice of collaborating partners is underpinned by the partner's interest in the project's long-term benefits (Barnes et al., 2002, 2006). In addition, individuals play a relevant role in project success (Perkmann et al., 2013); hence, the importance of having individuals who are committed, motivated and open to the learning process (Calamel et al., 2012; Canhoto et al., 2016).

Collaborative R&D&I projects should benefit all stakeholders (Pinnington and Scanlon, 2009). Industry benefits are largely economic, i.e., new or improved products/processes, cost efficiency, quality improvements and enhanced competitiveness. There can also be institutional benefits, i.e., access to new technologies and knowledge, the possibility to hire students, enhancement of the firm's innovative capabilities and acceleration of the commercialisation of intellectual properties (Calamel et al., 2012; Ankrah and AL-Tabbaa, 2015; Nsanzumuhire and Groot, 2020). On the other hand, HEIs can also benefit economically by creating business opportunities, additional income, and resource provision. HEIs can also have some institutional benefits, such as: the introduction of students to real problems and technologies, encouraging research in certain areas, publication of papers by scholars, increasing HEIs' credibility and joint publications with industry (Ankrah and AL-Tabbaa, 2015; Nsanzumuhire and Groot, 2020). Finally, there are also benefits for public funding entities (Klosko, 2013), such as: improvement of local economic development, new employment opportunities (especially for students) and the reinforcement of knowledge

transfer from HEIs to industry (Ankrah and AL-Tabbaa, 2015; De Fuentes and Dutrénit, 2012).

2.2. Project management practices

Different project contexts require particular PM practices (Besner and Hobbs, 2013), including practices that can address the challenges of collaboration (Perkmann et al., 2013; Pertuze, 2010). PM practices are only valuable if they can be integrated and adapted to specific PM processes (Thamhain, 1998). PM practices are the skills, tools and processes required to manage a project (Westland, 2006). Various PM practices are considered crucial (Barnes et al., 2006). PM practices that address cultural and organisational differences between HEIs and industries (Barnes et al., 2002) are often considered critical success factors (Simões et al., 2021).

It is commonly accepted that the PM lifecycle is divided into four phases (Project Management Institute, 2021; Westland, 2006): Initiation, Planning, Execution (monitoring/controlling & replanning), and Closure. Concerning PM approaches, the PMBOK (Project Management Institute, 2021) presents three main approaches: the traditional method is used when projects can be defined early and do not go through significant changes once the environment is stable. The adaptive approach is used primarily when the project context is volatile and has high levels of uncertainty. Therefore, project requirements are bound to change during its progress. Finally, the hybrid approach combines features from traditional and adaptive approaches. Thus, the main difference between those approaches is the rigidness level. Even though all three aim to increase project success, it still needs to be determined which approach is best selected for collaborative R&D&I (Bravo et al., 2021). Fernandes and O'Sullivan (2023) suggested the use of a hybrid approach.

In collaborative R&D&I, PM practices can improve communication, align stakeholders' expectations, promote long-term relationships and many other benefits (Fernandes et al., 2020a,b). PM practices support many of the processes referred to above and are defined as the tools and techniques, such as documents, checklists, and templates, by which PM processes are delivered and supported. They are the mechanisms project managers and project team members use to help them in their roles (Barbosa et al., 2021; Besner and Hobbs, 2006; Fernandes et al., 2013; Fernandes and O'Sullivan, 2023). A set of 35 PM practices (see Table 1) have been identified as transversal practices, in other words, that can be used regardless of the PM (Besner and Hobbs, 2006; Brocke and Lippe, 2015; Chin et al., 2011; Ankrah and AL-Tabbaa, 2015; Fernandes and O'Sullivan, 2023; Nsanzumuhire and Groot, 2020). These practices are appropriate for collaborative R&D&I PM.

In summary, PM practices are used to support practitioners in executing collaborative R&D&I projects efficiently and effectively (Fernandes, O'Sullivan et al., 2020). However, these practices can only be effective once they are embedded within an organisation's working culture (Fernandes et al., 2015a) and then actually enhance the organisation's PM maturity.

As highlighted by Cooke-Davies et al. (2009), prior research indicates that project success is intrinsically linked to the alignment between the specific characteristics of the project, the strategies adopted, and the context in which the project is implemented, which is usually referred to as "fit". However, despite the variety of "misfits" that can lead to project failure (Payne and Turner, 1999), there is a gap in literature regarding the PM practices 'use misfit'. This misfit can pose additional challenges, particularly when it comes to leading teams through complex and ever-changing contexts as in collaborative R&D&I projects.

Leadership plays a crucial role in the failure or success of projects. Studies demonstrate that effective leadership, such as transformational leadership and Leader-Member Exchange, can mitigate the negative impacts of misfit on work outcomes (Boon and Biron, 2016; Zhang et al., 2012). Moreover, creating an appropriate leadership culture within companies allows for project managers to further develop their skills

Table 1
Project management practices transversal to Collaborative R&D&I projects.

Phase	Practices	Description
Initiation (I)	Project idea paper	Problem statements, the objectives, benefits, and principal tasks and deliverables
	Alignment workshops	Internal team alignment meetings among partners
	Project charter	Benefits, objectives, scope, timelines, costs, and resources
	Stakeholder register	Interests, influences, and expectations of all key stakeholders
	Kick-off meeting	Initial meeting outlining objectives, organisation, and practices
	Project competences list	Technical and managerial competencies, skills, practices, and training
	Benefits register	Expected benefits and key performance indicators
Planning (P)	Project scope plan	Deliverables and quality acceptance criteria
	Work breakdown structure	Work breakdown structure (e.g., work packages and tasks)
	Gantt chart	Project start dates, dues dates and milestones
	Milestone list	Key milestones and due dates
	Project staff plan	Human resource availability and commitments
	Responsibility assignment matrix	Activities vs. responsibilities matrices
	Risk register	Risks, causes, ranking (severity vs impact), risk responses
	Dissemination and communication plan	Communication needs, formats, and responsibilities
	Project procurement plan	Purchasing of goods or services and subcontracting
Execution (E)	Requirement analysis	Internal and external requirements and technical specifications
	Ongoing delivery	Interim periodic results, status, and progress
	Progress meetings	Meeting with key stakeholder groups (governance, partners, customers, etc.)
	Innovation meetings	Periodic discussion and analysis of novelty, creativity, and exploitation potential
	Progress reports	Record of progress, innovation, and other meetings
	Project issue log	Critical issues arising and remedial actions
	External audits	Progress audits and action plans by external and independent assessors
	Quality inspection	Quality audits and actions plans by internal and independent assessors
	Lesson learned register	Lessons learned (e.g., successes, failures, performance, etc.)
	New project ideas log	New project ideas for future R&D&I projects
	Change log	Changes to the scope, schedule, resources, etc.
	Team building	Team building and milestones social events
	Communication and dissemination	Communication and dissemination of interim and final project results
	Benefits monitoring	Continuous monitoring of long-term benefits
	Re-baselining	Changes in scope, costs, time, and resources, among others
	Stakeholder satisfaction surveys	Periodic evaluation of stakeholder satisfaction
Closure (C)	Transition plan	Transfer and exploitation plan of project results
	Project closure meeting	Discussion and record of successes, failures and lessons learned
	Project closure report	Activities vs. responsibilities matrices

(Fareed et al., 2023).

Therefore, this paper aims to explore the fit between the use and usefulness of PM practices and identify possible causes for any misfit, along with the strategies needed to overcome them. By considering the role of leadership in mediating the effects of the 'use misfit', organisations can enhance the effectiveness of their PM practices and ultimately improve project success (Fareed et al., 2023).

3. Research methodology

A mixed methods research approach enables complementarity and mitigates the 'method effect', leading to more reliable results and conclusions (Saunders et al., 2019). Firstly, quantitative data were collected through an online questionnaire, which obtained 465 responses regarding the use and usefulness of the 35 PM practices. Although it was possible to address the qualitative component of the survey in a question, a mixed methodology was chosen to explore aspects where observing facial expressions and engaging in direct interaction with the interviewees convey information and sentiments that the impersonality of a survey cannot capture (Saunders et al., 2019). Accordingly, twelve semi-structured interviews were conducted to qualitatively explore specific results of the online questionnaire findings further.

3.1. Online survey

Quantitative data was collected from May 2022 until September 2022. During this period, 5946 potential respondents involved in past or present collaborative R&D&I projects supported by the Portuguese Innovation Agency were emailed. The questionnaire survey was disseminated through the Portuguese Innovation Agency's monthly newsletter, website, and LinkedIn page. Altogether, the number of valid responses was 465, which, despite being less than 10% of the potential respondents, it was deemed more than sufficient to conduct significant statistical analysis, with the minimum required being 380 responses at a confidence level of 95% at the margin of error ±5% (Sample Size Calculator by Raosoft, 2023).

Respondents were asked about the use and usefulness of the 35 PM practices following a five-point Likert scale (Joshi et al., 2015). The use scope ranged from '1' – Do not use; '2' – Use seldom; '3' – Use sometimes; '4' – Use frequently and '5' – Always use whereas the usefulness scale scope ranged from '1' – Very low; '2'- Low; '3' – Medium; '4' – High and '5' – Very high. The collected data was analysed using descriptive statistical measurements such as the mean, median, and standard deviation. Fit analysis compared the mean value for the use and the mean value for the usefulness of each PM practice (Zimmermann et al. (2020). To determine the degree of fit, a new variable named 'GAP' was calculated as follows (1):

$$\overline{x}_{use} - \overline{x}_{usefulness} \quad (1)$$

A tolerance of one standard deviation of the GAP variable for both sides was defined, meaning that PM practices that have a GAP value higher than one standard deviation have a misfit, i.e., are outside the fit zone. This choice of one standard deviation value was based on Zimmermann et al. (2020), who conducted a similar fit analysis in a different context.

Most respondents worked in industrial firms (58.2%), followed by universities at 22.8%, with the remaining 19% with other R&D institutions. Considering the Portuguese definition of Small/Medium Enterprises (SMEs), as defined by the Decree-Law nº372/2007, which categorises SMEs as those with between 50 and 250 employees and annual turnovers not exceeding 50 million euros, or whose annual balance sheet totals do not exceed 43 million euros, more than half of the firms (53.5%) were SMEs, with 20% being Large Companies (22.9%), while the remaining were divided into Spin-offs, Start-ups, and Micro Companies. The roles of academic respondents included 72.8% professors, 24.3% researchers, and 2.9% grantees. The roles of non-academic respondents were 71.1% director, coordinator, or board member positions and 28.6% technicians.

Participants were also segregated according to their roles in collaborative R&D&I projects and years of experience. The roles were: (Co) Responsible (57.8%), Technical/Scientific team member (13.1%), Steering Committee member (5.6%) and Project Management team member (23.4%). Additionally, more than 50% of the respondents had seven or more years of experience with collaborative R&D&I projects (7–10 years: 15.3%; 10–15 years: 17% and >15 years: 23%), with the remaining distributed as follows: 19.4% with 4–6 years, 22.1% with 1–3 years and lastly 3.2% with less than a year of experience. This concluded that the respondents had high expertise and knowledge on collaborative R&D&I PM. Finally, 59.8% of the participants reported that their organisation had a structure/system to support PM. In comparison, 37.2% stated that they did not have any PM structure/system, and the remainder of 3% did not know.

3.2. Semi-structured interviews

The semi-structured interviews were conducted after the initial findings from the questionnaire data analysis to explore its findings further and build in-depth explanations for the results (Saunders et al., 2019). The interviews were designed to last an hour, so interviewees had enough time to develop their answers. The fact that the interviews were semi-structured some questions be designed in advance. The interviews were conducted in Portuguese and lasted an average 30 min. All interviews were recorded, and permission was secured to facilitate data analysis and translation and avoid bias or misinterpretation. In total, 30 potential participants were asked to participate through emails, culminating in 12 interviews (conducted between June 2023 and July 2023) from nine organisations varying from HEIs, firms, Government, and other R&D institutions. This is a sufficient number, according to Hennink and Kaiser (2022), once saturation of the answers was achieved. The profiles of the participants are shown in Table 2.

All the interview answers were analysed using thematic analysis, an iterative process that requires the researchers' interpretation and reinterpretation of the data collected. After all the interviews were transcribed, data was coded into themes with similar meanings or similar keys. These themes represent the causes for misfits and the strategies to overcome them, which are presented and further discussed in the following sections.

4. Results

Research results are divided into two sub-sections: the first section will address the questionnaire survey results and the uses, usefulness, and gaps between use and usefulness. The second section will present the semi-structured interview findings, including strategies for overcoming gaps of misfit practices.

4.1. Survey results

PM practices were ordered according to their mean value, and the standard deviation was used as a tiebreaker, meaning that when two practices had the same mean value, the one that presented the lower standard deviation was ordered higher. Table 3 shows the complete list of the PM practices according to their use and usefulness.

Mean values ranged from 4.40 (Kick-off meeting) to 2.38 (Stakeholder satisfaction surveys), with the standard deviation (SD) varying from 0.876 to 1.367. The median values were distributed as follows: 3 PM. practices with a value '5', 14 PM practices with a value '4', 15 PM practices with a value '3' and finally 3 PM practices with a value '2'.

It is possible to observe that practitioners tend to agree more on the perceived usefulness of the PM practices rather than on their use once both the intervals for the mean, between 4.46 and 3.30, and the standard deviation, ranging from 0.697 to 1.061 are smaller for the former,

Table 2
Interviewee profiles.

No.	Organisation	Perspective	Occupation	Collaborative PM Experience	Education Level
1	Organisation 1	Government	Executive Board Member	>15 years	PhD degree
2	Organisation 2	HEI	Director and PMO	7–10 years	Post-graduation
3	Organisation 3	HEI	Team member	1–3 years	Master degree
4	Organisation 3	HEI	Team member	1–3 years	Master degree
5	Organisation 4	Government	PMO	4–6 years	Post-graduation (MBA)
6	Organisation 5	Interface	PMO	7–10 years	Master degree
7	Organisation 1	Government	CoLAB network manager	4–6 years	Master degree
8	Organisation 6	Firm	Innovation projects coordinator	10–12 years	Master degree
9	Organisation 7	HEI	PMO	>15 years	PhD degree
10	Organisation 8	Firm	Project manager	>15 years	Bachelor degree
11	Organisation 6	Firm	PMO	7–10 years	Bachelor degree
12	Organisation 9	Firm	CEO	10–15 years	PhD degree

Table 3
PM practices 'use' and 'usefulness'.

Phase	PM Practice	Use			Usefulness		
		Mean	Median	SD	Mean	Median	SD
I	Alignment workshops	4	4	0.954	4.35	4	0.697
	Benefits Register	3.29	3	1.194	3.86	4	0.822
	Kick-off meeting	4.4	5	0.919	4.46	5	0.703
	Project charter	3.6	4	1.2	4.04	4	0.839
	Project competences list	3.15	3	1.246	3.69	4	0.883
	Project idea paper	3.81	4	1.218	4.25	4	0.758
	Stakeholder register	2.79	3	1.218	3.56	4	0.868
P	Dissemination and communication plan	3.06	3	1.243	3.61	4	0.918
	Gantt chart	4.39	5	0.95	4.36	5	0.799
	Milestone list	4.2	4	1.014	4.26	4	0.807
	Project procurement plan	2.98	3	1.367	3.63	4	1.042
	Project scope plan	3.63	4	1.209	4.01	4	0.847
	Project staff plan	3.39	4	1.234	3.87	4	0.87
	Responsibility assignment matrix	3.19	3	1.284	3.88	4	0.897
	Risk register	3.17	3	1.211	3.75	4	0.869
	Work breakdown structure (WBS)	3.29	3	1.328	3.81	4	0.933
E	Benefits monitoring	2.43	2	1.256	3.37	3	0.98
	Change log	3.57	4	1.182	3.95	4	0.863
	Communication and dissemination	3.81	4	1.057	4.01	4	0.885
	External audits	2.54	2	1.224	3.3	3	1.061
	Innovation meetings	3.11	3	1.139	3.76	4	0.911
	Lesson learned register	3.1	3	1.249	3.86	4	0.878
	New project ideas log	3.35	3	1.19	3.87	4	0.911
	Ongoing delivery	3.84	4	1.072	4.02	4	0.848
	Progress meetings	4.29	4	0.876	4.37	4	0.74
	Progress reports	3.72	4	1.176	3.8	4	0.951
	Project issue log	3.11	3	1.206	3.56	4	0.949
	Quality inspection	2.96	3	1.276	3.73	4	0.894
	Re-baselining	3.47	4	1.096	3.84	4	0.833
	Requirement analysis	3.76	4	1.18	4.12	4	0.898
	Stakeholder satisfaction surveys	2.38	2	1.185	3.41	3	0.966
	Team building	2.84	3	1.328	3.8	4	0.982
C	Project closure meeting	4.03	4	1.183	4.27	4	0.81
	Project closure report	4.09	5	1.196	4.26	4	0.777
	Transition plan	2.77	3	1.269	3.83	4	0.875

indicating that the use of PM practices among respondents has a higher variation. Regarding the median values, only 2 PM practices had the value '5', followed by 85% of the PM practices (30) that had a value of '4', and finally 3 PM practices had a value of '3'.

Once the PM practices had been ordered according to their mean value, it was possible to proceed to the fit analysis, which was done by calculating a new variable named 'GAP' using formula (1), which evidences the difference between the mean value for the use and the mean value for the usefulness of each PM practice. The GAP values are presented in Table 4, and the shaded PM practices are the ones that present a misfit because their GAP value is higher than the gap tolerance established. Table 4 also allocates a number index based on the alphabetically sorted list of practices. These will be used later in Fig. 1.

Only 9 PM practices present a fit between their use and usefulness (**highlighted in bold**). Another important observation is that all 34 PM practices have a negative GAP apart from the 'Gantt chart'. A possible explanation is that Gantt Charts are one of the most well-known and widely used PM practices globally (Besner and Hobbs, 2008). Additionally, its use does not require a high level of expertise. Therefore, it can even be used by inexperienced practitioners (Tereso et al., 2019) without any organisational investment or assistance (Fernandes et al., 2013). Moreover, the 'Gantt chart' is typically required by many organisations and stakeholders as a prerequisite for project planning and communication (Geraldi and Lechter, 2012). Particularly in collaborative R&D&I projects, most of which are publicly funded, and the chronogram is commonly a mandatory requirement in the funding

Table 4
PM practices 'GAP'.

Index	Phase	PM Practice	Use	Usefulness	GAP
			Mean	Mean	
1	I	Alignment workshops	4.00	4.35	−0.35
2	E	Benefits monitoring	2.43	3.37	−0.94
3	I	Benefits Register	3.29	3.86	−0.57
4	E	Change log	3.57	3.95	−0.38
5	**E**	**Communication and dissemination**	**3.81**	**4.01**	**−0.20**
6	P	Dissemination and communication plan	3.06	3.61	−0.55
7	E	External audits	2.54	3.30	−0.76
8	**P**	**Gantt chart**	**4.39**	**4.36**	**0.03**
9	E	Innovation meetings	3.11	3.76	−0.65
10	**I**	**Kick-off meeting**	**4.40**	**4.46**	**−0.06**
11	E	Lesson learned register	3.10	3.86	−0.76
12	**P**	**Milestone list**	**4.20**	**4.26**	**−0.06**
13	E	New project ideas log	3.35	3.87	−0.52
14	**E**	**Ongoing delivery**	**3.84**	**4.02**	**−0.18**
15	**E**	**Progress meetings**	**4.29**	**4.37**	**−0.08**
16	**E**	**Progress reports**	**3.72**	**3.80**	**−0.08**
17	I	Project charter	3.60	4.04	−0.44
18	**C**	**Project closure meeting**	**4.03**	**4.27**	**−0.24**
19	**C**	**Project closure report**	**4.09**	**4.26**	**−0.17**
20	I	Project competences list	3.15	3.69	−0.54
21	I	Project idea paper	3.81	4.25	−0.44
22	E	Project issue log	3.11	3.56	−0.45
23	P	Project procurement plan	2.98	3.63	−0.65
24	P	Project scope plan	3.63	4.01	−0.38
25	P	Project staff plan	3.39	3.87	−0.48
26	E	Quality inspection	2.96	3.73	−0.77
27	E	Re-baselining	3.47	3.84	−0.37
28	E	Requirement analysis	3.76	4.12	−0.36
29	P	Responsibility assignment matrix	3.19	3.88	−0.69
30	P	Risk register	3.17	3.75	−0.58
31	I	Stakeholder register	2.79	3.56	−0.77
32	E	Stakeholder satisfaction surveys	2.38	3.41	−1.03
33	E	Team building	2.84	3.80	−0.96
34	C	Transition plan	2.77	3.83	−1.06
35	P	Work breakdown structure (WBS)	3.29	3.81	−0.52

application.

Furthermore, the observation that all PM practices, except for one, exhibit a negative GAP —meaning that the perceived usefulness surpasses the actual usage— leads us to conclude that these practices are indeed perceived as valuable and useful. However, they are still being underused, resulting in a total of 26 PM practices showing a misfit.

Fig. 1 shows the fit zone, where from the perfect fit line (y = x), a tolerance of one standard deviation of the GAP variable for both sides was created, meaning that PM practices that have a GAP value higher than absolute 0.29 have a misfit, i.e., are outside the fit zone.

It is worth noting that two types of misfits are possible, even though our data only reveals one type. The PM practices above the fit zone are considered to have a 'use misfit'. In other words, they should be more used, considering respondents' perceived usefulness level. On the other hand, PM practices under the fit zone are deemed to have a 'usefulness misfit', which would result if practitioners were overusing PM practices despite not perceiving them as very useful.

4.2. *Semi-structured interviews*

Realising from the questionnaire results that around 74% (26) of the PM practices have a 'use misfit', it was necessary to explore the causes and possible explanations for this high number of PM practices having a misfit. Hence, additional data was collected through semi-structured interviews. The results of the thematic analysis suggest five key causes as to why the 'use misfit' occurs. PM practitioners perceive most PM practices as being useful but also that many practices are not used effectively. These perceptions are expressed verbatim in the sample quotations presented in Table 5.

It is worth noting that some of these causes are cited in the literature as associated problems with embedded PM practice in organisations, such as the lack of time (Atkinson et al., 2006) or lack of PM culture (Barnes et al., 2006; Fernandes et al., 2015b).

During the analysis, several proposed strategies were discussed among participants and researchers to overcome the causes of the 'use misfit' practices. The outcome of these discussions leads to a number of potential enhancement strategies such as: the provision of training in practices and soft skills; shifting the management focus towards societal impact; greater leadership skills; enhancing professionalisation of PM (e.g., establishing a Project Management Office) and; greater alignment between partners at the start of the project. These strategies are explored in more detail in the next section. All interviewees agreed that the reality of PM, in busy work environments remains stubbornly focused on delivering projects 'on time', 'on scope', and 'on budget'.

5. Discussion

5.1. *Fit PM practices*

Even though all 35 practices are important for managing collaborative R&D&I projects, it is understandable that some might be more valuable of useful than others. Hence, we highlight the top-10 'most

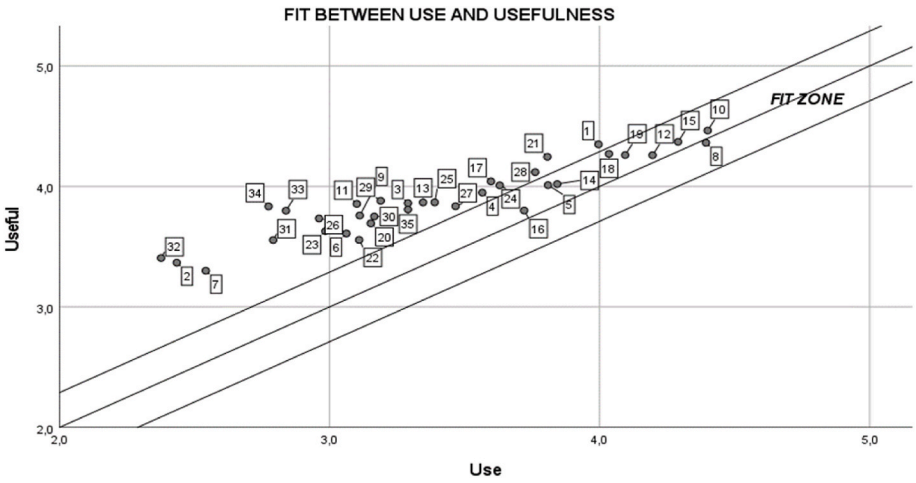

Fig. 1. – Fit between 'Use' and 'Usefulness'. The number represents the PM practice indexed in Table 4.

Table 5
Key causes contributing to the 'use misfit'.

Causes	Interviewees quote examples
Lack of practical knowledge	*"There is an awareness of the existence of these PM practices, but knowing they exist is one thing, and being able to implement them is another."* (Interviewee no.3) *"… Without practical applicability, theoretical training is worthless."* (Interviewee no.7)
Too much focus on project outputs delivery	*"Our primary focus remains on adhering on scope, on time, and on budget, even though we are trying to monitor the project impacts. Nevertheless, how we get there is not important, there is insufficient emphasis on implementing supportive PM practices."* (Interviewee no.11) *"The first thing we think about is 'what do we have to do', not 'how we're going to do it', and this lack of methods sometimes leads us to forget good practices."* (Interviewee no.5)
Lack of time	*"When we organize the project staff and made the resource allocation to tasks, commonly our challenge arises from the fact that these resources are often involved in various other functions and responsibilities within the organisation, lacking time to dedicate to PM activities."* (Interviewee no.3) *"People spend more than half their time-solving problems, this makes it more difficult to stop and think about implementing good practices."* (Interviewee no.11)
Disagreement on deployment of PM practices	*"Project teams come from different organisations with varying working processes, making it sometimes challenging to agree on a common approach to work together."* (Interviewee no.4) *"The larger the project, the greater the need for PM practices in these types of projects. However, culture makes things difficult to introduce."* (Interviewee no.11)
Lack of PM culture	*If an organisation doesn't have PM practices firmly embedded in its organisations, is even more difficult to adopt PM practices in these collaborative projects."* (Interviewee no.4) *:"It's difficult to implement these practices because people are not used to implement them, we always have to give training."*(Interviewee no.4)

used' (Fig. 2) and top-10 'most useful' (Fig. 3) PM practices.

The first significant result worth discussing is that both top-10s have PM practices that cover entirely the typical PM lifecycle. Therefore, we can conclude that these PM practices are extensively used from the beginning of a project until its ends and, more importantly, their use is perceived as useful since 8 out of 10 PM practices that are in the top-10 'most used' are also in the top-10 'most useful'.

Figs. 2 and 3 show that the 'Initiation' phase has more PM practices than the remaining phases, which leads us to conclude that this phase and its processes require additional attention from practitioners. This finding aligns with Besner and Hobbs (2006), who concluded that the initiation phase is critical, and its process must be supported and carefully completed to avoid compromising the subsequent phases (Project Management Institute, 2021).

The use of some PM practices from this phase are beneficial for dealing with typical causes cited for project failure. For example, the use of a 'project charter' can support the definition of project requirements, such as the objectives and the expected benefits that builds the momentum essential for the success of collaborative R&D&I projects (Canhoto et al., 2016). Also, when used jointly by all partners, involvement and motivation can be enhanced (Roman, 2006). Moreover, by using the 'project charter' combined with the 'kick-off meeting' and 'alignment workshops', project objectives, goals and benefits can be thoroughly discussed and agreed upon by all stakeholders to enhance greater alignment and clarity (Barnes et al., 2006; Rohrbeck and Arnold, 2006).

It is worth mentioning that the 'project charter' and the 'requirement analysis' are not present in the top-10 'most used', even though they are considered very useful according to the practitioners, which is why they present as a 'use misfit'.

From the fit analysis, it is interesting to notice that apart from the 'progress reports', all the other 8 PM practices inside the fit zone are either in the top-10 'most used' or in both top-10s. Therefore, following a similar idea of the 'intrinsic value' proposed by Besner and Hobbs (2006), we can consider that these 9 PM practices are being used at an adequate frequency, which means that their potential to improve PM performance is being fully exploited, and considered very useful.

Considering current PM strategies, the minimum set consists of nine key PM practices, meaning that they should be used to ensure a minimum level of PM professionalism (Fig. 4).

This insight led to the first of two empirical propositions:

Proposition 1. *There is set of 'must have' PM practices that should be used to manage successfully collaborative R&D&I projects. These 'must have' PM practices are: Kick-off meeting, Gantt chart, milestone list, progress meetings, ongoing delivery, communication and dissemination of results, progress reports, project closure report, and project closure meeting.*

5.2. Use misfit PM practices

All the remaining 26 PM practices present a 'use misfit', which means there may be unused potential for them to improve project performance through more extensive or better use (Besner and Hobbs, 2006). Using the order of priority in Table 3 combined with the GAP values (Table 4), professionals can select those PM practices that need more significant support and guidance. Practitioners can opt to choose PM practices that are either ranked in higher positions in the use and usefulness since the respondents perceive them as important, or PM practices with high GAP value because these practices still have a lot of potentials to improve project performance to be explored. It is worth mentioning that practitioners should also consider the project's specificities and characteristics when selecting PM practices for training and support (Besner and Hobbs, 2012, 2013).

For the value of PM practices to be fully exploited, it is necessary to understand the reasons why many practices are underused despite being

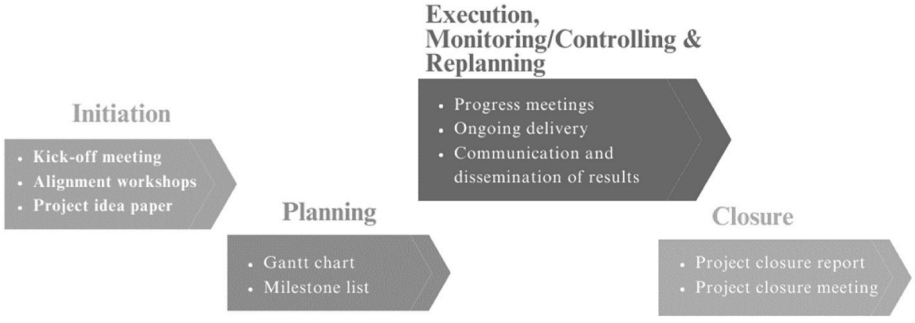

Fig. 2. – Top-10 most 'used' practices.

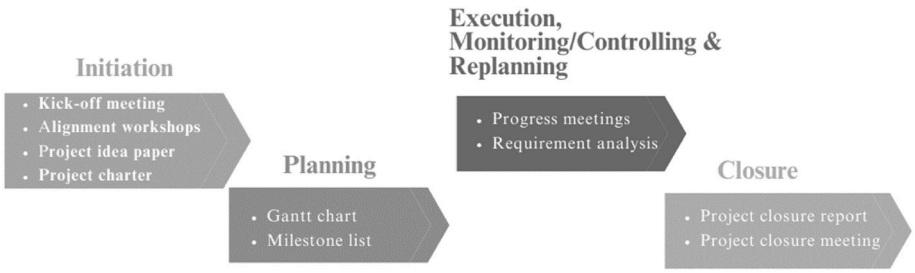

Fig. 3. – Top-10 most 'useful' practices.

Fig. 4. Key PM practices for collaborative R&D&I projects.

considered necessary. Intervieweeno.8 highlighted this: *"These practices are fundamental for us to have answers, I would say solid answers, to the problems that appear to us, so that adequate measures can be made"*. Specific 'most useful' PM practices must be deeply incorporated within an organisation's working routines so that project performance can be effectively improved (Fernandes et al., 2015b). Hence, the importance of promoting the use of PM practices by their perceived usefulness.

Most interviewees believed that the 'use misfit' is triggered by multiple factors. The most common cause mentioned by almost 60% of the interviewees is the 'lack of practical knowledge'. The interviewees understood that practitioners are usually familiar with PM practices from a theoretical perspective. Interviewee no.7 noted*: "I think … staff training (is important), but not (exclusively) theoretical training, …practical training (…). Without practical applicability, theoretical training is worthless"*.

In the questionnaire survey results, apart from the 'Gantt chart', the mean values for usefulness were consistently higher than those for using each PM practice. However, practitioners do not generally use PM practices because they lack the necessary knowledge to implement them. Thus, we believe that this difference between theoretical knowledge and the actual knowledge of using them in a project is the leading cause that prevents PM practices from being used more frequently and achieving their full potential. Most interviewees suggested the 'provision of training', especially with practical examples, is the most suitable strategy to overcome the 'lack of practical knowledge'. One of the interviewees noted: *"Investing in training practices is crucial. Having a practical example is fundamental so that staff can gain knowledge effectively"*.

The fact that there is 'too much focus on project outputs delivery' also contributes to PM practices being underused. As interviewee no.1 stated: *"The main decision-makers thought that it [PM practices] doesn't matter and what matters is that things happen, and the outputs appear, and they don't want to know what's in between"*. Additionally, the reality of PM is still very focused on delivering projects within the 'Iron Triangle' (scope, budget, and time), especially from a funding stakeholder perspective. This is highlighted in the comment made by interviewee no.1*: "Scope, budget and time are the basics mainly from a financing perspective"*. This creates pressure for projects to be rushed so that their outputs are delivered within these criteria pragmatically without the support of PM practices, *"The project team arrives only to execute, and then simply executes without rethinking" as mentioned by interviewee no.4*.

Overcoming this barrier, there was a suggestion to first 'shift the management focus towards societal impact' since project managers are usually more aware of PM collaboration for a more sustainable future through the perspective of its processes instead of the role they play in influencing society and organisations (Magano et al., 2021), this is, their impact. Also noted by respondents was that 'leadership' can help facilitate the 'shift of the management focus towards societal impact' (Ruiz et al., 2022) by *"Making the project team aware of the importance of the project's impact from the beginning"*. Moreover, project managers who adopt a transformational leadership style encourage an open and flexible headspace for team members to innovate (Brocke and Lippe, 2015) and inspire their colleagues by understanding and promoting key motivating factors (Fareed et al., 2021).

The 'lack of time' is due to the fact that participants of collaborative R&D&I projects usually have other responsibilities and roles within their organisation. For example, HEIs' participants are usually professors, which means constrained time availability, which leads to projects being managed without using some PM practices, as mentioned by interviewee no.3: *"I think it's down to the number of things that each manager has, for example. Imagine, sometimes there are too many teams, projects and subprojects to deal with, and you don't have enough time to be there preparing for the end of the project and revisiting it"*.

Once more, 'leadership' can be helpful in demonstrating the value of these PM practices by influencing team members' values (Pieterse et al., 2009). Interviewee no.9 mentioned: *"Showing the benefits of delivering a project in line with the practices through a leader is essential. Because it demonstrates the value and everything that has value, we find time to develop"*. It was also suggested that the 'professionalisation of PM', e.g. setting up a PMO, can be beneficial once it functions as a facilitator for PM practice implementation (Karim et al., 2022), reducing the time of routine activities and optimising the time available for PM.

Another cause for the 'use misfit' is the existence of partners from different organisations with divergent working processes (Rohrbeck and Arnold, 2006), which can cause 'disagreement on PM practices to use'. To remedy this, practices must be defined and agreed upon as early as possible (Lappalainen et al., 2023). Most interviewees also stated that the best strategy to overcome this was to 'align before the start of the

project', which PM practices will be used throughout the project lifecycle and creating a "PM manual". In addition, some of the interviewees stressed the importance of defining these PM practices along with partners during meetings, therefore establishing a common language and good communication channels, which are beneficial for enhancing trust (Chin et al., 2011; König et al., 2013) and critical for project success (Anantatmula and Rad, 2018).

Finally, the 'lack of PM culture' among practitioners also contributes to PM practices needing more use. As interviewee no.4 mentioned, *"You have to have discipline in PM"*. Consequently, 'providing training' to project managers on soft skills, including leadership styles, provides maximum motivation (Rehman et al., 2020), and enhancing and enhances teamwork (Anantatmula and Thomas, 2010). Moreover, Fareed et al. (2021) suggested combining intellectual and emotional intelligence is better for project success. A project manager's 'leadership' significantly enhances a project's sustainability (Magano et al., 2021). Leadership emerges as a key strategy to mitigate three out of five of the main causes for the 'use misfit'. This insight led to the second proposition:

Proposition 2. *Leadership plays a crucial role in overcoming the 'use misfit' of PM practices, which can be caused by multiple factors, such as lack of PM culture or simply a lack of time on the part of PM professionals.*

6. Conclusion

Our research provides important theoretical and practical contributions to the PM literature in the context of collaborative R&D&I projects. Firstly, our results emphasises the importance of using PM practices throughout the complete PM lifecycle (Project Management Institute, 2021). This is illustrated in the top-10 'most used' and 'most useful' PM practices. It is worth of mentioning that respondents considered PM practices from the 'Initiation' phase as crucial since three and four PM practices from this phase are in the top-10 'most used' and top-10 'most useful' PM practices, respectively. This is interpreted due to their importance in mitigating common causes for failure, such as misaligned and unclear objectives (Barnes et al., 2006; Rohrbeck and Arnold, 2006) and lack of involvement/commitment (Harris, 2007).

Secondly, by integrating in the research study, the fit between the use and usefulness of PM practices, lead us to conclude that there is a set of 'must have' practices that should be used to manage successfully collaborative R&D&I projects. We identified a set of nine practices with a perfect fit, encompassing the entirety of the PM lifecycle, and eight of these PM practices are either in the top-10 'most used' or 'most useful' or even in both. From a theoretical point of view the identification of the 'must have' set of PM practices expands the results made by Faccin and Balestrin (2018) improving our PM knowledge at an inter-organisational level. From a practical perspective, we encourage practitioners to use our rankings with the inclusion of 'use misfit' information to support their selection of PM practices to apply in the context of collaborative R&D&I projects.

Thirdly, this research allowed us to identify five causes leading to a 'use misfit' in 26 PM practices, some of which are already mentioned in the literature, related to the problems associated to embed PM practices, such as the lack of PM culture. Despite being perceived as useful, practitioners still underuse them because they usually need the necessary practical knowledge to implement them. Moreover, stakeholders are generally mainly interested in the final outputs of the collaborative R&D&I project, resulting in PM that is still very focused on delivering projects 'on time', 'on scope', and 'on budget'. These causes contribute to some PM practices not being used frequently by practitioners, who have scarce time availability due to other demands within their organisation.

Additional reasons contributing to the 'use misfit' include the fact that partners tend to disagree on which PM practices should be used, and this suggests a need for more focus on enhancing PM culture (norms, practices, and behaviours). With this in mind, we have suggested some actions that can be taken to reduce the gap between use and usefulness so that the potential of the practices can be better utilised for example, having a leader who can demonstrate the practically and importance of critical practices and encourage their use.

Ultimately, this research supports the critical role of leadership in overcoming the 'use misfit' of PM practices. Leadership is a means to mitigate three of the five reasons for the 'use misfit'. This, in turn, affirms the notion that a project manager as a team leader, through their skills, competencies, and leadership style, plays an essential role in the success of a project. Leadership plays a critical role in choosing PM practices, tools and techniques by aligning them with the strategic objectives and benefits, providing the necessary resources, setting expectations, monitoring progress, and making informed decisions. Leaders' ability to adapt and adjust to PM practices is essential for a successful PM.

Nonetheless, R&D&I must play a pivotal role in effecting transformative changes across all levels to combat, alter, and adapt to the multifaceted repercussions of our dynamic global landscape (DG RTD, 2023). Consequently, future studies will be essential to enhance and consistently uphold the currency of R&D&I projects, ensuring their ongoing societal benefits and influence shaping the perception and utilisation of PM practices.

Limitations of this research primarily stem from its focus on the Portuguese context. However, our findings and contributions could potentially be generalised due to the collaborative nature of R&D&I projects in Portugal, typically funded and supported by the European Union, involving partners and participants from various countries. Nevertheless, conducting a similar survey in other geographical contexts on a more global scale may yield valuable new insights. Moreover, it may also be important to explore the effect of selected PM practices on the performance and success of collaborative R&D&I projects.

CRediT authorship contribution statement

Gabriela Fernandes: Writing – review & editing, Conceptualization, Methodology, Data Collection, Formal analysis, Funding acquisition, Project administration, Supervision. **Guilherme Tassari:** Writing – original draft, Data Collection, Formal analysis. **Lucas Rocha:** Writing – original draft, Formal analysis. **José M.R.C.A. Santos:** Writing – review & editing, Conceptualization, Methodology, Formal analysis. **Luís Miguel D.F. Ferreira:** Writing – review & editing, Methodology, Formal analysis. **Pedro Ribeiro:** Writing - review & editing, Methodology, Formal analysis. **David O'Sullivan:** Writing – review & editing, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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