Review

A Theoretical Framework for MADMs in the Intelligent Leading and Allocation of Human Resources in R&D Projects

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A Theoretical Framework for MADMs in the Intelligent Leading and Allocation of Human Resources in R&D Projects

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Abstract

This paper examines the key factors influencing the performance of research and development projects, synthesising recurring themes and insights from existing literature. The analysis identifies 49 distinct factors and illustrates how often they are referenced in the context of managerial discourse and practice. The frequency with which these factors appear is not interpreted as a measure of their actual impact, but rather as an indicator of managerial attention to specific challenges. These factors are organised into a functional model comprising four interrelated categories: strategic orientation, operational execution, organisational competence and innovative-adaptive potential. The primary contribution of this research is the development of a theoretical framework for the application of multi-criteria decision-making tools to assess and enhance project success, especially in the allocation of human resources in research and development settings. The findings emphasise the importance of adopting flexible, context-sensitive approaches to managing the performance of scientific and technological research projects.

Keywords: research and development; human resource allocation; multi-criteria decision-making; DEMATEL method; strategic project management; project performance factors

1. Introduction

Research and development (R&D) is an essential pillar of scientific and technological progress, closely associated with innovation and economic competitiveness. In this context, intellectual capital is the most important resource for research entities, as the success of projects depends on the expertise, creativity, knowledge and social skills of those involved [1–3]. Within the European Union, the pressure to attract and manage funds through competitive programmes requires that project proposals must be continuously improved. This enables research organisations to secure funding and deliver exceptional performance. However, competing for research funding from the same source can lead to conflicts regarding the allocation of resources by the approving authority. Statistics from the European Union's Framework Programme for Science and Innovation suggest that resource conflicts have prevented around 20% of transnational collaborative research projects from meeting their research objectives within the expected timeframe [4]. Furthermore, projects continue to fail at a surprising rate, regardless of type or industry [5] 75% of projects fail before ever reaching implementation (James & Frank, 2015). The literature argues that most factors influencing project performance are primarily linked to human resources (HR) [6–8]. Thus, a major obstacle to successful projects lies in human resource management (HRM), i.e. how teams of researchers are assigned, how tasks are distributed according to ability, and targeting methods and techniques. Without a dedicated

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tool for efficiently planning and allocating these resources, an organisation's ability to successfully complete projects or win funding for their implementation can be impacted. Problems such as the inefficient distribution of tasks, a mismatch between team competencies and project requirements, and difficulties in meeting deadlines can lead to delays, additional costs, and less favourable results [4,8–10]. These issues are further compounded in R&D projects, where tasks are varied and require specialised skills, and time and budget constraints are commonplace. Additionally, research teams often comprise specialists with varying degrees of experience, making optimal organisation challenging without an effective HR system that considers knowledge transfer at the team level, e.g. succession planning. The management of project-based organisations is an important research topic due to the widespread use of this organisational form and its idiosyncratic challenges [11].

Researchers in STEAM (Science, Technology, Engineering, Arts and Mathematics) and researchers in HRM generally agree that a systematic approach to HR practices is better than a one-dimensional approach. However, there is still no consensus on exactly what should be included in a high-performance work system [8], even though multi-attribute decision-making methods (MADMs) have become one of the most popular topics in decision theory literature [6–8,10,11]. There is clearly a need for a tool that can integrate multiple variables, such as skills, task complexity, time and budget constraints, in order to optimise the distribution of HR in projects. Due to the multidimensional and complex nature of these factors, common statistical models are not useful for examining project performance through the lens of HRM [8].

The aim is to develop a MADMs-based framework that can prioritise criteria within the HR allocation process, utilising the capabilities of MADMs to address a variety of criteria. This would improve project planning and, consequently, project performance. However, the absence of an extensive list of factors that determine the success of R&D projects poses an obstacle to the development of this decision support framework. The question motivating the present study is therefore: "What attributes determine the success of R&D projects?" These must be considered in all research activities, whether qualitative or quantitative. The potential outcomes are multiple and diverse, including MADMs frameworks for the intelligent leading and allocation of human resources in R&D projects implemented by academic institutions or industrial organisations. To answer this question, a literature review will be conducted, including articles in the field of management and studies presenting the results of R&D projects which offer insights into project management.

2. Materials and Methods

To identify the key concepts associated with project performance measurement, a literature review was conducted, focusing on R&D. This included reviewing models and theoretical frameworks commonly used in project performance assessment in the R&D sector. Key concepts that measure potential project performance, as determined in the project planning phase, have been listed from these.

The search was performed in the Web of Science (WoS) Core Collection which returned 32 scientific article results, published in the last 5 years for the query formula:

$$\begin{aligned} \boldsymbol{TS} = ((&Research\boldsymbol{OR}"R\&D"\boldsymbol{OR}"ResearchandDevelopment") \\ &\boldsymbol{AND}Project \\ \boldsymbol{AND}(&Performan* \boldsymbol{OR}Success* \boldsymbol{OR}Efficien* \boldsymbol{OR}Productiv* \boldsymbol{OR}Outcome \\ &* \boldsymbol{OR}Impact) \\ &\boldsymbol{AND}Management \\ &\boldsymbol{AND}Factor* \\ &\boldsymbol{AND}Evaluat* \\ \boldsymbol{AND}(&Plan* \boldsymbol{OR}Alloc* \boldsymbol{OR}Distribut*) \\ &\boldsymbol{AND}Resourc* \\ &\boldsymbol{AND}Strateg*) \end{aligned} \quad (1)$$

Where the "*" symbol (truncation) allows the inclusion of all derivatives, such as "Success" and 'Successfully' for the phrase "Success*".

This formula was employed to enhance the accuracy of searches (Table 1).

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Table 1. Justification of the query formula.

Query formula sequence	Role
TS (Topic Search)	Search in title, abstract, keywords written by author/authors, keywords suggested by WoS.
Project	Ensure results focus on projects.
Research ***OR***R&D ***OR*** *"Research and Development"*	Includes all variants related to R&D.
Performan ***OR*** *Success ∗* ***OR*** *Efficien ∗* ***OR*** *Productiv ∗* ***OR*** *Outcome ∗* ***OR*** *Impact*	This group of terms refers to concepts associated with measuring project performance.
Management	Focus the results on project management issues.
Factor ∗	Identifies articles that present studies on factors that may influence the performance of R&D projects.
Evaluat ∗	Returns studies addressing project performance evaluation.
Plan ∗ ***OR*** *Alloc ∗* ***OR*** *Distribut ∗*	It covers terms such as 'planning', 'allocation' and 'distribution' and their derivatives, which are relevant in the resource planning phase of projects.
Resourc ∗	Search for articles that analyze the management and allocation of resources in a project.
Strateg ∗	Identifies papers that analyze effective project planning.

Each article was analysed to identify the main concepts contributing to performance (Table 2). Each literature source was assigned a code ranging from A to AF.

Table 2. Articles included in the bibliographic search.

Symbol	Title of the article	Reference	No. addressed elements characteristic of project performance
A	"Evaluating the impact of internet communication quality in human resource management on the productivity of construction projects" [12]	(Al-aloosy et al., 2024)	16
B	"Project management in manufacturing enterprises" [13]	(Vrchota & Řehoř, 2021)	24
C	"Lean system-based tool for housing projects management in the pandemic period" [14]	(Sundararajan & Madhavi, 2023)	21
D	"A method for managing scientific research project resource conflicts and predicting risks using BP neural networks" [4]	(Dong & Qiu, 2024)	19

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E	"Optimizing capital allocation in microfinance projects: an experimental case study in Barranquilla, Colombia" [1]	(de la Puente Pacheco et al., 2024)	18
F	"Divergent agricultural water governance scenarios: The case of Zayanderud basin, Iran" [15]	(Nazemi et al., 2020)	24
G	"Identifying and assessing complexity emergent behaviour during mega infrastructure construction in Sub-Saharan Africa" [16]	(Abdullahi et al., 2022)	23
H	"The CSFs from the perspective of users in achieving ERP system implementation and post-implementation success: A case of saudi arabian food industry" [17]	(Salih et al., 2022)	22
I	"Quantitative evaluation and ranking of the critical success factors for modular integrated construction projects" [3]	(Wuni et al., 2022)	24
J	"Sustainable harvest training in a common pool resource setting in the Peruvian Amazon: Limitations and opportunities" [18]	(Romulo et al., 2022)	30
K	"An intuitionistic linguistic DEMATEL-based network model for effective national defense and force innovative project planning" [19]	(Sun, 2021)	19
L	"Estimation of water balance for anticipated land use in the Potohar Plateau of the Indus Basin using SWAT" [20]	(Idrees et al., 2022)	13
M	"A multi-attribute framework for the selection of high-performance work systems: the hybrid DEMATEL-MABAC model" [8]	(Estiri et al., 2021)	23
N	"Efficiency of higher education financial resource allocation from the perspective of 'double first-class' construction: A three-stage global super slacks-based measure analysis" [21]	(J. Wang et al., 2024)	18
O	"An evaluation tool for assessing coral restoration efforts" [22]	(Schopmeyer et al., 2024)	19
P	"A novel Pythagorean fuzzy PERT approach to measure criticality with multi-criteria in project management problems" [23]	(Akram & Habib, 2024)	13
Q	"Building a digital bridge to support patient-centered care transitions from hospital to home for older adults with complex care needs: protocol for a co-design, implementation, and evaluation study" [24]	(Gray et al., 2020)	19
R	"Risk assessment and management in the offshore wind power industry: A focus on component handling operations in ports" [25]	(Lin & Lu, 2023)	23
S	"Design and implementation of electronic health record-based tools to support a weight management program in primary care" [26]	(Kukhareva et al., 2024)	17
T	"Evaluation of the impacts of land use/cover changes on water balance of Bilate watershed, Rift valley basin, Ethiopia" [27]	(Sulamo et al., 2021)	11

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U	"Implementing public involvement throughout the research process-Experience and learning from the GPs in EDs study" [28]	(Evans et al., 2022)	20
V	"Factors explaining program sustainability: a study of the implementation of a social services program in Sweden" [29]	(Åhlfeldt et al., 2023)	20
W	"Comprehensive benefit evaluation of solar PV projects based on multi-criteria decision grey relation projection method: Evidence from 5 counties in China" [30]	(C. Wang et al., 2022)	12
X	"Implementing smart city strategies in Greece: Appetite for success" [31]	(Siokas et al., 2021)	24
Y	"The relapsed acute lymphoblastic leukemia network (ReALLNet): a multidisciplinary project from the spanish society of pediatric hematology and oncology (SEHOP)" [32]	(Velasco et al., 2023)	12
Z	"Priorities and potential challenges of sustainable management of ultra-deep groundwater resources in Iran" [33]	(Aghamir, 2024)	24
AA	"Transnational water resource management in the Karawanken/Karavanke UNESCO Global Geopark" [34]	(Schmalzl et al., 2022)	15
AB	"Dynamic hybrid model for comprehensive risk assessment: A Case study of train derailment due to coupler failure" [35]	(Appoh & Yunusa-Kaltungo, 2022)	8
AC	"Effects of land-use intensity on vegetation dynamics across elevation in Savanna Grassland, Southern Ethiopia" [36]	(Yongdong et al., 2024)	12
AD	"Recent trends in nitrogen cycle and eco-efficient nitrogen management strategies in aerobic rice system" [37]	(Farooq et al., 2022)	13
AE	"Spinal cord injury management policies in high school sports as reported by athletic administrators" [38]	(Scarneo-Miller et al., 2024)	15
AF	"Managed wildfire: A strategy facilitated by civil society partnerships and interagency cooperation" [39]	(Davis et al., 2022)	12

The most frequently mentioned factors (≥50%) in the studied literature are risks, clarity of project objectives, costs, consistent processes and standards, control methods and techniques, timeframe, education and training, allocation of material resources, communication management, productivity, sustainability, social impact, innovation and creativity, long-term orientation and human resource expertise, transparency of decision-making and know-how acquired, coordination methods and techniques.

Table 3 provides a comprehensive overview of the factors considered important when evaluating the potential performance of research and development (R&D) projects. Using a quantitative comparative approach, 49 factors were identified and analysed based on their frequency of occurrence in the examined corpus. This provides a panoramic view not only of the factors invoked in performance appraisal, but also of managerial priorities and dimensions perceived as essential in organisational practice.

It is important to note that the frequency with which a particular factor is mentioned does not reflect its objective value or intrinsic importance in determining project performance. Rather, this frequency indicates the degree of managerial attention given to these factors. In other words, the data

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show what is taken into account more often, not what is decisive in all situations. Some factors that are mentioned less frequently may have a disproportionately high impact in particular contexts or at critical phases of the project. Therefore, factors such as 'risks' (30 mentions), 'clarity of objectives' (26 mentions), 'costs' (26 mentions) and 'standardisation of processes' (24 mentions) are invoked most often not because they necessarily have a greater impact than others, but because they are easier to conceptualise, measure and manage in the context of current managerial decisions. Consequently, an asymmetry emerges between operational perception and systemic impact that needs to be treated with caution in decision modelling.

To build a solid framework for multi-criteria decision-making in R&D project management, it is essential to have a granular understanding of each of the factors identified in the literature. The 49 factors outline a broad spectrum of factors that can significantly influence the outcomes, coherence, resilience and efficiency of a scientific project.

R&D projects do not operate in isolation, but within a complex organisational space where interactions between different variables determine not only the results, but also the viability of the processes involved. Analysing the 49 factors extracted from the literature enables us to map this territory, where performance does not result from a single dominant parameter, but from a network of multiple conditioning factors in a state of constant tension and balance.

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At the heart of this ecosystem lies a team's capacity to perform well under pressure and uncertainty, and frequently in the absence of clear precedent. Risks thus become an inevitable backdrop against which all other decisions are made [40,41], not just a management element. Having clear objectives acts as a strategic stabiliser, providing benchmarks for activities and criteria for measuring progress [42–45]. Meeting deadlines remains a constant test of internal organisation. However, performance is not just about time or money. Although costs are central to planning, they only make sense in relation to productivity and tangible results [33]. These results are rarely purely quantitative; they also require added value, innovation, creativity, and the ability to generate transferable knowledge [46]. This is precisely where invisible factors such as organisational culture, leadership style and trust environment come into play — variables that cannot easily be quantified but which decisively shape behaviours, decisions and, ultimately, success.

Effective communication is not just a means of exchanging information; it is also a way of coordinating the intellectual efforts of specialists with different backgrounds and perspectives [47]. Interpersonal relations and human resource behaviour are especially important in situations of deadlock or conflicting priorities [48,49], when projects are not just about numbers, but also about willingness to collaborate, negotiate, and support joint efforts.

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Table 3. Factors that measure the potential performance of projects, mentioned in the literature.

Factors	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	No. of appearances
Risks	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	30
Clarity of project objectives	X	X	X	X			X	X	X	X	X	X	X	X	X		X		X			X	X	X	X	X	X	X	X	X	X	X	26
Costs		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X		X	X	X	X	X	X	X	X	X		26
Consistent processes / Standards		X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X		X	X		X	X	X		24
Control methods and techniques	X	X	X	X		X	X	X	X	X	X			X	X		X	X	X		X	X		X	X	X	X	X			X		23
Timing	X	X	X	X	X		X	X	X	X	X	X			X	X	X	X		X					X	X	X		X	X	X		22
Education and training	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X					X		X					X	X	21
Allocation of material resources		X	X	X	X	X	X	X		X	X	X		X	X	X	X	X		X	X	X		X	X	X							21
Communication management	X	X	X		X	X		X	X	X	X		X		X		X	X	X		X	X		X	X	X					X		20
Productivity	X	X	X	X	X	X	X		X		X	X	X	X			X						X	X		X	X		X	X			19
Sustainability		X	X		X	X			X	X		X		X	X				X	X		X	X	X		X	X		X	X		X	19
Social impact					X	X				X	X	X		X	X		X			X	X	X	X	X		X	X		X	X	X	X	19
Innovation and creativity		X	X	X	X	X	X	X	X				X	X			X					X	X	X	X	X	X			X			18
Sustainability and long-term orientation						X		X		X		X		X	X		X	X		X		X	X	X	X	X	X		X	X		X	18
Human resource expertise	X	X		X			X		X	X	X		X			X		X	X		X	X		X		X					X		16
Transparency of decision-making		X	X	X	X	X	X	X	X	X			X					X			X	X		X		X	X						16
Know- how acquired		X	X		X	X	X	X	X	X				X	X			X	X		X					X					X	X	16
Coordination methods and techniques			X		X	X	X	X	X		X		X		X			X		X	X	X				X	X					X	16
Leading methods and techniques	X	X	X	X	X	X		X	X	X			X					X	X		X	X				X							15
Analysis methods and techniques									X			X		X	X	X			X	X	X		X	X	X	X		X	X	X				15
Interpersonal relations	X	X	X	X		X		X	X				X		X		X	X			X			X										13
Customer/beneficiary orientation		X			X	X		X	X				X	X			X		X		X	X		X	X									13
Economic impact									X		X	X		X	X		X			X			X	X		X	X		X	X				13
Task allocation	X	X	X	X			X			X	X		X			X		X	X		X													12
Organizational culture	X			X	X			X					X		X		X	X				X		X								X		11
Organizational policies	X					X	X	X		X	X							X						X				X			X	X		11
Leadership style	X	X	X			X				X								X			X	X				X								9
Management support		X	X	X				X	X				X								X	X									X			9
Feasibility		X	X			X	X		X		X					X	X		X															9

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Working conditions	X				X		X	X	X						X						X		X								8
Team size		X		X		X		X	X	X								X											X		8
Dependency on other projects					X			X	X		X		X	X					X	X											7
Access to resources													X						X		X	X		X			X	X			7
Environment of trust		X		X				X		X				X			X														6
Procurement					X		X	X	X							X		X													6
Number of information sources						X						X			X						X		X		X						6
Organizational infrastructure					X		X	X	X						X																5
Number of activities						X					X				X	X	X														5
Data security				X		X			X												X										4
Human resource behaviors										X						X													X		3
Number of improvisations						X							X				X														3
Risk tolerance													X												X						2
Age of team members	X																											X			2
Gender distribution				X																											1
Absenteeism rate										X																					1
Staff turnover rate										X																					1
Employee resilience										X																					1
Method of remuneration										X																					1
Number of outputs											X																				1

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At a strictly operational level, clear standards [50,51], effective control [52,53] and validated analysis techniques provide the project with a functional backbone. However, these need to be made flexible through adaptive coordination, intelligent task allocation and the continuous adjustment of effort according to resources and constraints. No matter how well the structure is designed, the project becomes fragile without a properly trained, motivated and distributed team [54].

The education, experience, age and gender of team members can all influence internal dynamics. In this context, leadership is not only manifested in hierarchical control, but also in the ability to create an environment in which employees feel supported and valued [54]. This state of trust generates resilience — the internal strength that enables the team to persevere despite obstacles, temporary setbacks and unforeseen limitations.

At the same time, structural factors such as remuneration methods, absenteeism and staff turnover should not be ignored. These factors provide insight into the team's actual state, the balance between commitments and benefits, and the sustainability of the collective effort [8]. For a project to be successful, it must not only achieve its formal objectives, it must also be reproducible, leaving behind a functioning team, accumulated know-how and strengthened professional relationships [47].

Therefore, the value of a research project cannot be understood in terms of traditional indicators alone. It must be analysed within the context of a living system, where each factor contributes to either balance or imbalance. Whether we are talking about risk or task allocation, leadership or analytical methods, social impact or risk tolerance, each element matters not in isolation, but through the connections it establishes with the others.

In short, the 49 factors provide more than just a map of what 'matters'; they also map the contours of a system in which performance is emergent, often unpredictable and deeply dependent on human resources in all their forms — cognitive, emotional, relational and organisational. Therefore, any attempt at robust decision modelling must start with a deep understanding of the interplay between these factors in the specific context of each R&D project, rather than simply ordering them.

Frequency distribution analysis reveals a significant concentration of variables. Fifteen factors exceed the threshold of 20 mentions, indicating a polarisation of managerial attention around familiar and recurrent themes, such as control, resource allocation, lead times and productivity. This suggests a possible routinisation or 'organisational bias' effect, whereby certain themes are addressed excessively at the expense of others that are more difficult to quantify, such as trust, leadership style or behaviors. Mathematically, the frequency of factors follows a long-tail distribution: a small group of variables concentrates the majority of occurrences while a significant number of factors are mentioned sporadically. This dynamic is common in systems where decisions are influenced by dominant paradigms, established practices or limitations in measuring intangible qualities

3. Theoretical Framework for MADMs-Based HRM in R&D Projects

The factors can therefore be grouped into four major categories, each reflecting a distinct but interdependent dimension of R&D project performance. A rigorous conceptual interpretation of the factors enables them to be organised into a coherent functional structure that goes beyond their mere frequency of occurrence in the literature.

The first category encompasses the strategic elements involved in managing uncertainty, setting the project's direction, ensuring long-term viability and incorporating sustainability principles. Clear objectives, an extensive vision and sustainability criteria are key to providing coherence and guidance in the architecture of complex projects.

The second category consists of operational parameters that reflect specific delivery mechanisms. These include costs, delivery deadlines, standardised procedures, task distribution and control tools. These factors are essential for maintaining design discipline, allocative efficiency, and compliance with assumed processes.

The third category focuses on the project's competency infrastructure and the mechanisms that govern the functioning of the internal team. This includes the level of education, the specialisation of human resources, the leadership styles adopted, and the dominant organisational values. These

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factors influence organisational cohesion, adaptability, and resilience to internal and external variables.

The fourth category includes variables that express the project's adaptive dynamics and its potential to generate emergent value. Innovation, social impact, the accumulation of know-how, individual behaviours, and the level of trust within the collective all reflect the system's latent capacity to produce results that exceed initial planning. Although these factors are difficult to anticipate or quantify, they often become critical differentiators in a competitive environment. While these factors are not always easy to anticipate, they often represent real competitive advantages.

This structuring emphasises that a comprehensive assessment of project performance cannot be limited to one-dimensional or strictly quantitative analysis. Instead, it must consider the interplay between tangible and intangible dimensions and between perfectly measurable and emergent or relational variables. The latter often determine the real success of an initiative, but escape conventional evaluation tools. From this perspective, an effective decision model based on MADMs must not only consider the frequency with which factors are mentioned, but also their contextual relevance.

Depending on the project's typology, the team's maturity stage, the scientific field involved, and external pressures (e.g. the requirements of a competitive funding programme), some low-frequency factors may become essential catalysts for performance. Team resilience, organisational trust, and the stimulation of constructive improvisation are examples of variables that, although not among the most frequently invoked, can have a decisive influence on a project's ability to adapt to structural dysfunction or ambiguity.

Therefore, MADMs modelling must be sensitive to the interdependencies between factors and their ability to generate spillovers, synergies, or blocking effects. Simply aggregating weights based on their presence in the literature can lead to modelling errors, resulting in imbalanced decision schemes, where statistically prominent factors are overemphasised, while critical yet less visible ones are overlooked. Furthermore, certain latent variables may act as linking elements between the above-identified dimensions, amplifying or mitigating the impact of other factors. For instance, an organisational culture that promotes continuous learning could improve both operational efficiency and innovativeness without being directly responsible for either.

Taken together, the results indicate that any MADMs-based decision-making tool applicable to HRM in R&D projects must incorporate a pluralistic logic that recognizes the complexity and ambiguity inherent in this field. The prioritization of criteria should not only reflect a statistical average, but also a deep understanding of the decision-making context, the dynamism of scientific projects and the multifaceted nature of performance.

Specific filtering was performed to extract factors reflecting aspects of HRM, either directly or indirectly. Contrary to initial expectations, these factors were not found exclusively in the competency infrastructure category, but were distributed across all four of the above-described functional categories. For instance, control methods and the timeliness and transparency of decision-making belong to the operational or strategic sphere, yet they directly impact the performance of teams and human resources.

In total, 28 HRM-relevant factors were identified, representing approximately 57% of those analysed. This high proportion suggests that the success of research projects depends to a large extent on how human resources are planned, managed, and utilised. The list of these factors includes: control methods and techniques, time compliance, education and professional training, communication management, productivity, innovation and creativity, long-term orientation, human resources experience, transparent decision-making, acquired know-how, coordination methods and techniques, methods of employee motivation, analysis methods and techniques, interpersonal relations, task allocation, organisational culture, leadership style, team size, trust environment, human resource behaviours, risk tolerance, team members' age, gender distribution, absenteeism rate, staff turnover rate, employee resilience, remuneration method, numbler of outputs.

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This dispersion demonstrates the pervasiveness of human resources in all functional components of a project and the need to integrate HRM principles in a systemic and anticipatory manner. Therefore, the performance of R&D projects cannot be dissociated from the quality of human capital management, which becomes a strategic driver of differentiation and sustainability as well as operational support.5. Conclusions

4. Conclusions

This study identified and analysed a comprehensive set of 49 factors associated with the performance potential of R&D projects. These factors were selected based on their recurrence in the literature and their functional role in projects. Of these factors, 28 were found to be directly or indirectly related to HRM. These factors span all four major dimensions of project functioning — strategic, operational, organisational, and adaptive — thus highlighting the central and systemic role of HRM in determining project success.

Contrary to the initial assumption that human resource issues manifest only in terms of competencies and internal team dynamics, the analysis shows that these human factors are deeply embedded in the entire decision-making and executive structure of R&D projects. Variables such as control methods, timeframing, communication management, decision transparency, staff motivation, team resilience and know-how accumulation reflect the fact that human involvement is a fundamental structural component of performance, not just operational support.

This list of HR-relevant factors provides the basis for a conceptual and empirical framework for developing a MADMs model applicable to the planning and allocation of human resources in scientific projects. Such a framework enables the rigorous, evidence-based prioritisation of human criteria and their correlation with the strategic and operational needs of projects. This paves the way for qualitative and empirical contributions to the field of intelligent leading and allocation of HR in R&D projects.

In this context, the study goes beyond merely classifying performance factors to propose a solid basis for a more nuanced, anticipatory and contextualised approach to HRM in research environments. This contribution's value lies in its potential to inform decision-makers, project leaders, and institutional planners about how to direct, structure, and optimise human effort so that resource allocation becomes efficient, smart, and impact-oriented.

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