

Unlocking breakthroughs in portfolio strategies for radical projects: a literature review

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Abstract

Paper aims: The paper proposes to consolidate the fragmented discussions on radical innovation project portfolios, seeking to establish a conceptual landscape of radical innovation portfolio management and develop a theoretical-conceptual framework for understanding radical innovation portfolio management literature.

Originality: This research contributes to the literature by categorizing aspects of radical innovation portfolio management, providing a structured view of the field and a conceptual guideline for both researchers and practitioners.

Research methods: The study uses a systematic literature review with bibliometric and content analysis to examine the literature on radical innovation portfolio management.

Main findings: The review identified seven dimensions of radical innovation portfolio management: integration of the ideation process with the innovation portfolio; valuation methods and legitimacy of innovation projects; budget allocation for portfolio balancing; strategic alignment and portfolio sustainability; innovation portfolio performance; influence of mental models on project selection; and partnership and alliance portfolio. These results categorize aspects of radical innovation portfolio management and highlight the current state of research.

Implications for theory and practice: This work provides a research landscape on radical innovation portfolio management, identifying research gaps for future studies. For practitioners, it offers guidelines to improve decision-making, resource allocation, and innovation performance of radical innovation projects.

Keywords

Portfolio management. Radical innovation. Project valuation. Radical innovation projects.

How to cite this article: Copola Azenha, F., & Fleury, A. L. (2024). Unlocking breakthroughs in portfolio strategies for radical projects: a literature review. *Production*, 34, e20240060. <https://doi.org/10.1590/0103-6513.20240060>

Received: June 06, 2024; Accepted: Sep. 17, 2024.

1. Introduction

Decisions involving the selection and allocation of resources in projects is a complex activity for organizations (Chao et al., 2009; Lettice & Thomond, 2008; Zschocke et al., 2014; Petzold et al., 2023). In the organizational context, a project can be understood as a set of non-recurring activities and processes, with a determined target to achieve specific objectives (Gemünden et al., 2018). From the perspective of portfolio management, a project represents an investment by creating tangible or intangible assets which become part of the organization's assets (Heirman & Clarysse, 2007), regardless of the nature or the expected return of the projects (Baptestone & Rabechini Junior, 2018).

Portfolio management must involve the quantitative and qualitative aspects for project selection, considering the strategic and long-term aspects for investments compositions, grouping and allocating resources for the projects according to organizational objectives, as well as balancing organizational capacity for new investments (Müller et al., 2014). However, in a specific context of innovation projects, the role of portfolio management goes beyond balancing incremental and radical innovation; it should promote investment planning for sustainable and enduring organizational growth through the creation of new businesses (Ardito et al., 2019; Brook & Pagnanelli, 2014).



Specifically for radical innovation projects, portfolio management must balance strategic benefits, including new technological capabilities and potential cost reductions (Kang & Montoya, 2014; Tiberius et al., 2021), with inherent risks and uncertainties in both technical and market aspects involving in the projects (O'Connor & DeMartino, 2006). Uncertainty poses a challenge for radical innovation projects (Gomes et al., 2019), rendering traditional quantitative methods less suitable for valuation process (Paulson et al., 2007; Salerno et al., 2015). However, most of quantitative valuation methods traditionally apply in portfolio management tend to bias the decision process to incremental innovation, emphasizing in cash flow throughout project lifecycles (Cooper, 2013; Salerno et al., 2015). This fact hinders the development of innovative products and services, thereby impacting the strategic long-term business goals. (Ardito et al., 2019; Randhawa et al., 2021).

In the literature on innovation portfolio management, there is no consensus about the valuation methods and managerial approaches adopted for radical innovation projects (Nuno Castro & Pinto Ferreira, 2020). Nevertheless, discussions regarding portfolio management for radical innovation projects are emerging but scattered throughout the literature, underscoring the need for a comprehensive overview of existing theories about radical innovation portfolio management (Tiberius et al., 2021). Thus, the purpose of this paper is to conduct a systematic literature review to construct a theoretical framework for radical innovation portfolio management and identify the primary research drivers and opportunities for future work. Therefore, results of this work are justified by contributing to academic researchers by delineating the current state of literature, pointing towards novel research avenues, as well as offering practical guidance to practitioners in managing innovation portfolios within organizations.

2. Method

This research employs a bibliometric and content analysis approach, following the process established Carvalho et al. (2013). The Web of Knowledge and Scopus databases were chosen for well-recognized standing within academic community and stringent inclusion criteria, particularly the utilization of blind peer review, which contributes to a robust sample selection. The analysis aims to identify key authors, emerging trends, and research gaps within the field of radical innovation portfolio management.

2.1. Bibliometric analysis procedures

To construct the sample, the following search string was employed in Web of Science engine: “portfolio” AND (“radical” or “disruptive” or “breakthrough”) AND “innovati*”. The search process in the databases was conducted from September to November 2023, resulting in a sample of 291 articles. The terms “Article” and “Review” filter in the “Document Type” field was applied, leading to the exclusion of 101 articles, and resulting in a sample of 190 articles. A subsequent filter was applied on the categories “Business, Management and Accounting” and “Economics, Econometrics and Finance.” This filter led to the exclusion of 58 articles, thereby refining the sample to a total of 132 articles. The abstracts of the 132 articles were thoroughly examined and works not pertinent to the research focus were excluded. This procedure resulted in the exclusion of 71 articles, culminating in a final set of 61 articles. These articles, published across 28 different journals, span a period from 2003 to 2023.

Sampling data was imported into VosViewer (van Eck & Waltman, 2010) to construct a citation network. This analysis facilitated the identification of emerging trends and insights relevant to the topic, offering essential foundation for the content analysis process. Figure 1 illustrates the sample construction process:

2.2. Content analysis procedures

Content analysis had two objectives: identifying themes in radical innovation portfolio management and categorizing dimensions to uncover gaps and future research directions. This process was conducted on the final sample of 61 articles. Additional articles were incorporated using the snowballing technique (Carvalho et al., 2013). Thus, extracted data on authorship, methodology, research objectives, theoretical and practical content, and future research directions were organized into a categorization framework. Subsequently, the articles were organized on clusters identified within bibliometric analysis throughout citation network of keywords, which delineated the major research trends.

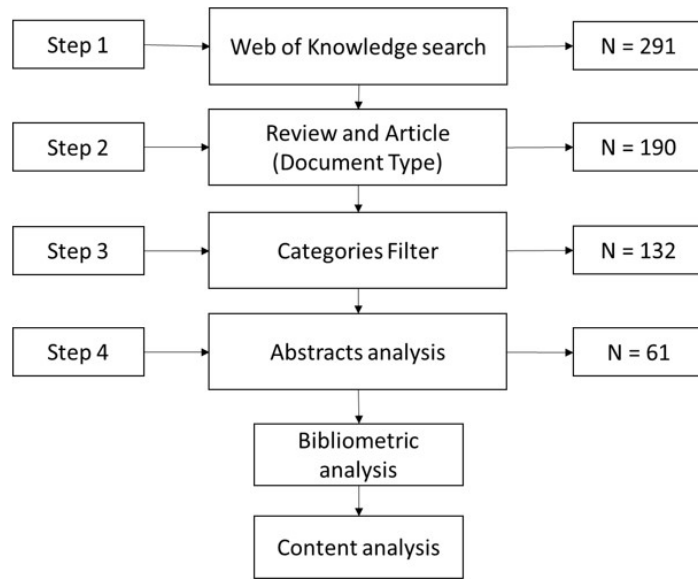


Figure 1. Samples construction process.

3. Bibliometric analysis results

Evolution of literature on radical innovation portfolio management begins in 2003. This starting point is marked by the publication of Sorescu et al. (2003). This work provides an in-depth analysis of the financial consequences associated with managing a portfolio of radical innovation projects in the pharmaceutical industry.

The samples display three peaks in publications from 2003 to 2023. The first peak, in 2014, included five publications, featuring the work of Brook & Paganelli (2014), who explored sustainability within radical innovation and proposed strategic integration between sustainability and portfolio management. Second peak, in 2019, showcased six publications, with Flechas Chaparro et al. (2019), making a significant contribution by examining methods for selecting and evaluating radical and incremental innovation projects, while analysing the investment dichotomy between the two categories of innovation.

In the period from 2021 to 2023, the samples encompass thirteen publications. Notably, Tiberius et al. (2021) delve into the significance of project portfolio theory and the real options approach as managerial tools for facilitating the valuation of radical innovation within organizations. Brasil et al. (2021) propose a multilevel framework for portfolio management, aiming to achieve a balance between radical and incremental innovation projects and ultimately fostering organizational ambidexterity. Additionally, Weinreich et al. (2022) and Ferras-Hernandez (2023) make significant contributions by describing strategic frameworks to address radical innovation from the portfolio investment perspective.

The samples reveal a significant spread of publications across various periodicals, with 61 articles distributed among 28 different journals. Notably, the Journal of Product Innovation Management leads with nine publications. Additionally, Research Technology Management boasts five publications, while the Journal of Engineering and Technology Management includes four. This dispersion underscores a multidisciplinary approach within the literature, suggesting that the topic is not confined to a specific niche.

Analysis of the citation network is presented in Figure 2 identified three clusters. The correlation between clusters reveal three major themes in the literature related to radical innovation portfolio management.

First cluster emerges from the research of Chao & Kavadias (2008), illustrating an *innovative resource management* perspective. Researchers aim to explore the complexities involved in achieving a balance between radical and incremental innovation within the portfolio. They utilize the strategic buckets approach, which advocates for dividing the overall new product development resource budget into smaller, more targeted budgets defined by the type of innovative effort.

Second cluster is based on the research by Sorescu et al. (2003), which focuses on radical innovations in pharmaceutical industry and their economic impact. This paper examines which firms are likely to introduce innovations, assesses the financial rewards associated with them, and explores variations in these rewards across different firms. Additionally, this study compares the value of innovations featuring breakthrough technology

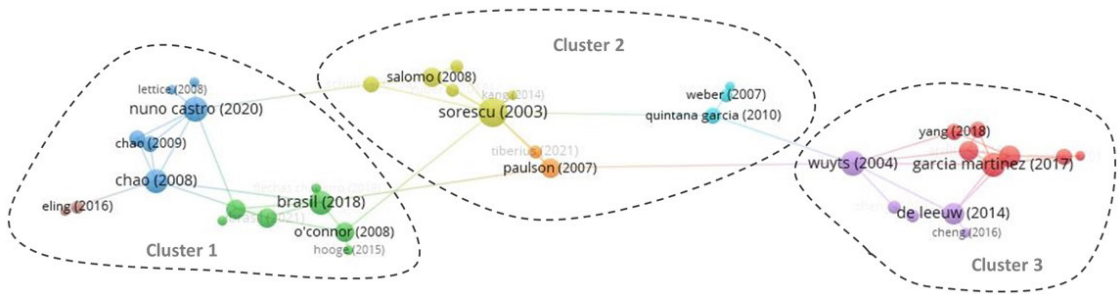


Figure 2. Citation network.

with those offering substantial customer benefits, determining which category yields greater value. Overall, the paper elucidates the *strategic and financial dynamics* characteristic of the cluster.

Third cluster draws from the research conducted by Garcia Martinez et al. (2017), examining the interplay between radical innovation and alliance synergies within open networks. The study explores how alliance portfolio diversity and Research & Development human capital influence innovation performance, understanding how managers can leverage open innovation for competitive advantage. This paper exemplifies the perspective on *open network alliances*, providing in-depth insights and analyses in this domain.

The similarity between clusters reinforces the three major themes in the literature related to radical innovation portfolio management. First theme deals with the discussion of financial aspects and allocation of resources within portfolio. Second theme encompasses works that address strategic aspects and discuss portfolio's balance from an organizational ambidexterity perspective. Finally, the third theme considers the management of alliances within the radical innovation portfolio. Thus, the bibliometric analysis facilitated the understanding of the chronological evolution of the literature, as well as enabling the identification of these three main lines around the management of radical innovation portfolios, that will be detailed in the next section.

4. Content analysis results

A thorough content analysis of the selected articles revealed seven key dimensions organized in a theoretical framework based on the bibliometric clusters.

4.1. Innovative resource management

Innovative resource management focuses on the allocation of resources within radical innovation portfolios, drawing on the resource-based view and product innovativeness. These studies examine management strategies for efficiently distributing resources across projects to foster innovation within organizations.

4.1.1. Integration between ideation process, innovation portfolio, and project portfolio

Literature offers two perspectives on innovation portfolio management (Castro et al., 2020; Mathews, 2010; Weinreich et al., 2022). According to the first perspective, the ideation phase, referred to as the fuzzy front end, is treated as a separate process from the project portfolio. Consequently, ideas undergo evaluation only once they have reached a certain maturity level (Heising, 2012; Petzold et al., 2023). The second perspective proposes integrating the ideation phase into the project portfolio selection process, arguing that concepts should be assessed progressively, even in their earliest stages of development (Eling et al., 2016; Ferras-Hernandez, 2023).

Mathews (2010) highlights differences between managing innovation portfolios and project portfolios. While project portfolios follow a defined strategy, innovation portfolios operate with flexible, adaptive strategies, initially guided by a strategic intention. During the ideation phase, concepts undergo refinement and testing until maturity (Yáñez-Valdés & Guerrero, 2023). The innovation portfolio's role is to analyze and evaluate concepts in their early stages (Castro et al., 2020; Heising, 2012), assessing their relevance before of evaluation process (Heidary Dahooie et al., 2023; Midler, 2019). This approach prevents premature exclusion at specific gates and avoids competition between radical and incremental innovation projects for resources within project portfolio (Castro et al., 2020; Mathews, 2011; Safdari Ranjbar & Fatemi, 2022).

Synergy between innovation and project portfolios offers organizations a management approach to spanning from early innovation stages form the scaled execution of projects. This integration facilitates a continuous evaluation process, preventing premature project rejection or underestimation of organizational benefits at premature stage. However, a thorough analysis of integration and respective implications is essential to understand the impact of portfolio management and strategic resource allocation throughout innovation valuation process, thus highlighting a significant avenue for further research.

4.1.2. Valuation methods and legitimacy of innovation projects

Several methods for project valuation are commonly utilized in portfolio management (Castro et al., 2020; Flechas Chaparro et al., 2019; Yáñez-Valdés & Guerrero, 2023; Zschocke et al., 2014). Valuation aims to identify projects with the highest potential for return on investment, whether financially or strategically (Chao & Kavadias, 2008; Cooper, 2013; Weinreich et al., 2022). These methods are often categorized as qualitative, semi-quantitative, and quantitative. The literature suggests that quantitative approaches are more suitable for incremental innovation projects, whereas qualitative approaches are preferable for radical innovation projects (Safdari Ranjbar & Fatemi, 2022).

The choice of valuation methods is not only influenced by type of innovation but also by maturity stage of the concepts implemented within the project portfolio (Castro et al., 2020; Zschocke et al., 2014). During the initial development stages of conceptualization of a project, it is recommended to rely primarily on qualitative methods to avoid premature rejection (Mathews, 2011; Petzold et al., 2023), gradually transitioning to more quantitative techniques as the project progresses through its development stages (Flechas Chaparro et al., 2019; Heidary Dahooie et al., 2023).

The search for recognition drives managers to adopt methods that facilitate project legitimization, securing funding and support (Ferrás-Hernandez, 2023; Miglietta et al., 2018; Vilkkumaa et al., 2015; Yáñez-Valdés & Guerrero, 2023). In organizational context, legitimacy is linked to both explicit incentives, such as remuneration and compensation, as well as implicit incentives, like career priorities and reputation (Chao et al., 2009). However, despite numerous studies presenting valuation models, there remains a gap in regarding the practical application of these models within innovative projects. Hence, there is a need to evaluate and describe empirical valuation models in radical innovation projects, representing a promising avenue for future research.

4.2. Strategic and financial dynamics

Strategic and financial dynamics examine the financial and strategic factors involved in managing radical innovation portfolios, with particular attention to balancing different types of innovation and employing methodologies for project valuation.

4.2.1. Budget allocation for balancing portfolio

Balancing of innovation projects is correlated with the concept of organizational ambidexterity (Petzold et al., 2023; Randhawa et al., 2021; Safdari Ranjbar & Fatemi, 2022). This involves finding an optimal balance between exploiting operations and exploring new avenues for product and service development (O'Connor, 2008; Srivastava & Gnyawali, 2011). From a financial perspective, the allocation of resources between radical and incremental innovation projects can be either fixed or variable. Moreover, financing model for a portfolio is linked to the level of managerial control and independence in utilizing revenue generated from existing products and services to support new ventures (Chao et al., 2009; Wang et al., 2023; Yáñez-Valdés & Guerrero, 2023).

In this sense, efficient budget allocation for portfolio management should be aligned with organizational strategy (Brook & Pagnanelli, 2014; Chao et al., 2009; Cooper, 2013; Farrington et al., 2012; Kang & Montoya, 2014). The literature indicates that an imbalance can present significant long-term risks to the organizational strategy, as well as overemphasizing new product and service development may disrupt operations without concurrent incremental improvement projects. However, focusing solely on incremental improvements can stifle innovation and organizational new business exploration (Chao & Kavadias, 2008; Kang & Montoya, 2014; Tiberius et al., 2021). Therefore, many research efforts have introduced models to assist organizations in establishing mechanisms that ensure a balanced distribution of projects within portfolio (Brasil et al., 2021; Farrington et al., 2012; Heidary Dahooie et al., 2023; Safdari Ranjbar & Fatemi, 2022).

Specifically Chao et al. (2009) emphasize the importance of both explicit incentives, like financial rewards, and implicit motivators, such as career priorities and reputation, in resource allocation process. When explicit incentives diminish, implicit ones gain more influence over decision-making. In situations where explicit incentives dominate, managers prioritize incremental projects for immediate financial gains (Duan et al., 2023;

Yáñez-Valdés & Guerrero, 2023). Given the prevalence of implicit incentives, managers tend to favor investing in disruptive product development, driven by organizational image and career aspirations, which significantly impact decision-making processes (Szutowski & Szulczynska, 2017).

Several studies indicate that partnerships and alliances play a significant role in shaping the balance of innovation portfolios (Ardito et al., 2019; Heidary Dahooie et al., 2023; Inigo et al., 2020; Safdari Ranjbar & Fatemi, 2022; Weinreich et al., 2022). However, there is a lack of research exploring the influence of innovation ecosystems on innovation portfolio balance. Thus, the propose of new studies that explore this gap represents an important avenue for further investigation in the literature.

4.2.2. Strategic alignment and value creation

Strategic alignment of portfolio aims at generating and maximizing value for the organization (Farrington et al., 2012; Ferras-Hernandez, 2023; Jugend et al., 2016). Value, in this context, encompasses the return on projects from a financial or strategic perspective (Cooper, 2013; Lettice & Thomond, 2008; Weinreich et al., 2022; Yáñez-Valdés & Guerrero, 2023). Talke et al. (2011) argue that the value of innovation project portfolio should consider three dimensions of sustainability: ecological, social, and economic. On the other hand, the model proposed by Brook & Pagnanelli (2014) provides a framework for categorizing innovation profile to assists companies in selecting and prioritizing projects with valuation techniques, thereby facilitating alignment with the organization's strategies.

However, strategic alignment and value maximization also influence the innovation portfolio's performance (Cooper, 2013; Kang & Montoya, 2014; Petzold et al., 2023). The project selection and prioritization should not only consider valuation methods but also ensure portfolio's sustainable configuration and alignment with organizational objectives. In this sense, studies investigating sustainability mechanisms to enhance the financial impact of radical innovation are lacking in the literature. Thus, explore the relationship between sustainability and financial value creation in innovation portfolio is a robust opportunity to further research.

4.2.3. Innovation portfolio performance

Portfolio balancing and project valuation methods play essential roles in helping organizations strategically performs in innovation projects. However, the complexity of organizational environment can significantly influence the perception of portfolio performance, often leading to a segmented performance horizon that leans towards short-term goals (Chao et al., 2009; Cooper, 2013; Heidary Dahooie et al., 2023). This fact tends to favour the emergence of incremental innovations (Kang & Montoya, 2014; Safdari Ranjbar & Fatemi, 2022). Yet, in highly risk environments, organizations often face limited time to acquire and refine the necessary capabilities for developing radical innovations. This constraint not only influences decision-making process and innovation performance outcomes but also affects organizational learning derived from uncertainty experiences (Flechas Chaparro et al., 2019; Petzold et al., 2023; Rafael et al., 2022; Weinreich et al., 2022). In this sense, evaluation of radical innovation project performance must be grounded in results and goals (De Leeuw et al., 2014; Kristiansen & Gertsen, 2015; Salomo et al., 2008). Moreover, assumptions generated by valuation methods should guide not only project selection but also the performance alignment of innovation portfolio considering the prioritized strategic directions (Brook & Pagnanelli, 2014; Chao & Kavadias, 2008; Ferras-Hernandez, 2023; Petzold et al., 2023; Talke et al., 2011).

According to Kristiansen & Gertsen (2015), developing ideal capabilities for radical innovation does not guarantee effective performance within organizations, as there often exists a gap between refined radical innovation capabilities and actual performance outcomes. Moreover, there is a common misconception in organizations that radical innovation projects outperform incremental ones due to higher financial expectations (Kang & Montoya, 2014; Weinreich et al., 2022). However, it is incremental projects that enable the financing of radical innovation projects (Gomes et al., 2019; Petzold et al., 2023; Safdari Ranjbar & Fatemi, 2022). Thus, achieving balance in portfolio aligning strategies to maximizing value are essential for evaluating innovation portfolio performance. However, there are no studies that describe and compare the state of practice of techniques applied to measure portfolio performance in organizations. Thus, research suggests and outlines mechanisms to evaluate and measure performance in radical innovation portfolios, highlighting this as an essential avenue for future studies.

4.3. Open network alliances

Open network alliances facilitate the linkage between an organization's alliance networks and its radical innovation portfolio. This relationship is particularly relevant in studies that explore the management of radical innovation within the context of open innovation networks.

4.3.1. Influence of mental models on project selection

Mental models are defined as organized knowledge structures that describe the forms, the purposes, and the operations of an organizational system, including its observed states, with a focus on predicting its future states (Rouse et al., 1992). Mental models also encompass shared belief structures among team members, which influence decision-making processes and task performance (Cannon-Bowers & Salas, 2001). Consequently, mental models influence managerial decisions in portfolio selection processes (Bessant et al., 2014; Hooge & Dalmaso, 2016; Lettice & Thomond, 2008; Weinreich et al., 2022). Managers may act restrictively, influenced by risk aversion and uncertainty inherent in decision-makers (Ferrás-Hernandez, 2023; Hooge & Dalmaso, 2016). However, they can also enhance decision-making towards innovation, particularly when informed by the historical successes of previous projects (Lettice & Thomond, 2008; Petzold et al., 2023).

Lettice & Thomond (2008) identify five mental models that minimize radical innovation projects prioritization: (1) rewarding incremental innovation; (2) ignoring positive benefits of radical innovation and/or reducing the negative aspects of incremental innovation; (3) emphasizing historical perceptions of project success; (4) fostering a sense of achievement linked to the efforts in incremental innovations; and (5) holding beliefs around unconfirmed information.

To address the challenges posed by managerial mental models, the implementation of financial strategies and processes does not ensure an assessment of innovation projects. To foster organizational transformation, interventions within portfolio management processes are necessary. Such interventions support portfolio managers in recognizing how mental models bias their perception of innovation, facilitating prioritization of strategies and portfolio selection opportunities (Lettice & Thomond, 2008). Engaging experts to mediate portfolio selection processes diminishes the likelihood of decision-making criteria, mitigating effects of biases in organizational mental models on decision process (Bessant et al., 2014; Weinreich et al., 2022). This fact could affect the innovation portfolio balance, representing a relevant factor for organizations in setting guidelines and policies regarding innovation. However, few studies investigate the influence of managerial mental models on selection process of radical innovation projects, revealing a gap for further research to enhance understanding of mental models' effects on decision-making process within radical innovation portfolio.

4.3.2. Partnership and alliance portfolio

Alliance portfolio concept is based on the establishment of a network of alliances, wherein organizations make efforts to share knowledge, resources, objectives, physical structures, assets, and budget allocations (Inigo et al., 2020; Petzold et al., 2023). This framework is designed to distribute risks and uncertainties and to catalyse the cultivation of organizational capabilities while fortifying pre-existing ones (Neyens et al., 2010; Wang et al., 2023).

At the organizational strategic level, configuring an alliance portfolio is crucial for fostering innovation (Oerlemans et al., 2013; Petzold et al., 2023). Additionally, building this portfolio and developing both local and international partnerships are key strategies for achieving organizational ambidexterity (Ardito et al., 2019; Inigo et al., 2020). However, radical innovation requires the establishment of close partnership ties with customers, while incremental innovation relies more heavily on established relationships with supply chain partners (Partanen et al., 2014; Wang et al., 2023).

Alliances should consider that complementarity and technological similarity between partners influence the development of both radical and incremental innovations (Cheng et al., 2016; Petzold et al., 2023). Partnerships with organizations that share similar technologies and knowledge tend to promote incremental innovation, while those with organizations offering complementary technologies and knowledge are more likely to foster radical innovation (Duan et al., 2023; Quintana-García & Benavides-Velasco, 2011).

Managing alliance portfolios is crucial for establishing partnerships that contribute to a well-balanced innovation portfolio (Inigo et al., 2020; Petzold et al., 2023; Quintana-García & Benavides-Velasco, 2010; Quintana García & Benavides Velasco, 2011). However, despite this established relationship, there is a lack of research exploring how project management models impact alliance portfolio performance. This gap is relevant avenue for further research to explore the potential relationships between project management and the alliance portfolio into the radical innovation portfolio management.

4.4. Consolidating the dimensions of radical innovation portfolio

To consolidate dimensions, Table 1 summarizes the articles in the samples used for content analysis, classified by the tree dimensions of radical innovation portfolio management.

Table 1. Dimensions of radical innovation portfolio.

Dimensions		Authors
Innovative resource management	Studies in this cluster highlight strategic resource allocation, especially concerning radical innovation and product innovativeness. They explore efficient resource distribution strategies to enhance organizational innovation.	<i>Integration between ideation process and innovation portfolio</i> (Castro et al., 2020; Heising, 2012; Le Loarne-Lemaire & Maalaoui, 2015; Mathews, 2010, 2011; Midler, 2019; Weinreich et al., 2022)
		<i>Valuation methods and legitimacy of innovation projects</i> (Brasil et al., 2018; Castro et al., 2020; Chao et al., 2009; Chao & Kavadias, 2008; Cooper, 2013; Eling et al., 2016; Flechas Chaparro et al., 2019; Heidary Dahooie et al., 2023; Kang & Montoya, 2014; Mathews, 2011, 2010; Miglietta et al., 2018; Paulson et al., 2007; Petzold et al., 2023; Salomo et al., 2008; Sorescu et al., 2003; Vilkkumaa et al., 2015; Volker et al., 2009; Weinreich et al., 2022; Wouters et al., 2011; Zschocke et al., 2014)
Strategic and financial dynamics	Studies in this cluster focus on managing a portfolio of radical innovations, emphasizing the balance needed between different types of innovation and appropriate valuation methodologies.	<i>Budget allocation for balancing portfolio</i> (Ardito et al., 2019; Brasil et al., 2021; Brook & Pagnanelli, 2014; Chao et al., 2009; Chao & Kavadias, 2008; Cooper, 2013; Farrington et al., 2012; Inigo et al., 2020; Kang & Montoya, 2014; O'Connor, 2008; Quintana-García & Benavides-Velasco, 2010, 2011; Randhawa et al., 2021; Safdari Ranjbar & Fatemi, 2022; Srivastava & Gnyawali, 2011; Szutowski & Szulczynska, 2017; Tiberius et al., 2021; Weinreich et al., 2022)
		<i>Strategic alignment and portfolio sustainability</i> (Brook & Pagnanelli, 2014; Cooper, 2013; Duhaylongsod & De Giovanni, 2019; Farrington et al., 2012; Heidary Dahooie et al., 2023; Jugend et al., 2016; Kang & Montoya, 2014; Petzold et al., 2023; Talke et al., 2011; Weinreich et al., 2022; Yáñez-Valdés & Guerrero, 2023)
		<i>Innovation Portfolio Performance</i> (Chao & Kavadias, 2008; Cooper, 2013; De Leeuw et al., 2014; Ferras-Hernandez, 2023; Garcia Martinez et al., 2017; Gomes et al., 2019; Heidary Dahooie et al., 2023; Kang & Montoya, 2014; Kristiansen & Gertsen, 2015; Rafael et al., 2022; Salomo et al., 2008; Schultz et al., 2013; Talke et al., 2011; Weinreich et al., 2022)
Open Network Alliances	Studies in this cluster explore the relationship between radical innovation and alliance synergies within open networks, examining the interplay between organizational alliance portfolios and radical innovation portfolios, encompassing research on managing radical innovation within open innovation networks.	<i>Influence of mental models on project selection</i> (Bessant et al., 2014; Heidary Dahooie et al., 2023; Hooge & Dalmasso, 2016; Lettice & Thomond, 2008)
		<i>Partnership and Alliance Portfolio</i> (Ardito et al., 2019; Cheng et al., 2016; De Leeuw et al., 2014; Duan et al., 2023; Garcia Martinez et al., 2017; Inigo et al., 2020; Neyens et al., 2010; Oerlemans et al., 2013; Partanen et al., 2014; Petzold et al., 2023; Quintana-García & Benavides-Velasco, 2011; Quintana García & Benavides Velasco, 2010; Wang et al., 2023; Yáñez-Valdés & Guerrero, 2023)

5. Discussion and future research

The analysis presented in previous section identified seven main dimensions for managing radical project portfolios, evidencing opportunities for future research. First, the integration of ideation activities with innovation portfolio is gaining significant attention in the innovation management literature since both approaches address a critical challenge: effectively evaluating concepts in their initial stages. By integrating these processes, organizations can avoid discarding valuable ideas too early and prevent investments in proposals that misalign with strategic goals. Some scholars even propose a management model that unifies ideation, innovation portfolio, and project portfolio (Heising, 2012; Mathews, 2010, 2011; Petzold et al., 2023; Weinreich et al., 2022). These models propose covering the entire innovation process, from concept emergence to advanced-stage project execution monitoring, laying the groundwork for a governance model for innovation, in alignment with O'Connor (2012) proposal. However, despite the intuitive appeal of formalizing management models for ideation phase and integrating them with project portfolio, empirical studies examining the consequences are notably scarce. There is a common perception that formalization may restrict creative process. Thus, exploring case studies of organizations that have implemented such integration presents a promising avenue for future research.

In organizations with environments involving high technological complexity, such as urban mobility (Heidary Dahooie et al., 2023) and defense (Safdari Ranjbar & Fatemi, 2022), balancing innovation portfolio is a key aspect of management. Hence, the portfolio should maintain a balance between radical and incremental innovation, as suggested by distinct sources (Cooper, 2013; Ferras-Hernandez, 2023; Safdari Ranjbar &

Fatemi, 2022; Tiberius et al., 2021). Moreover, this balance must also align with organizational strategy and environment, meaning that the proportion of each innovation type should be tailored considering the specific context (Chao & Kavadias, 2008). Thus, financing models and incentive policies play a crucial role in portfolio balance (Chao et al., 2009; Safdari Ranjbar & Fatemi, 2022; Yáñez-Valdés & Guerrero, 2023), considering the implications of restrictive mental models (Bessant et al., 2014; Lettice & Thomond, 2008), as discussed in cases presented by Gutiérrez & Magnusson (2014), by directly influencing the flexibility of the decision-making process and, in turn, the balancing of portfolio. Therefore, there is an opportunity for future research that explores how financing methods impact portfolio balancing within organizational strategies.

From a strategic perspective, the establishment of an alliance portfolio serves as a mechanism for driving innovation. The primary objective of diversifying partnerships is to leverage resources and knowledge for the advancement of innovative projects. However, literature lacks discussions on the potential impacts and relationships between alliance portfolios and project portfolio performance regarding the nature of radical innovation projects. Considering that partnerships through alliances can influence portfolio balancing and performance (Duan et al., 2023; Inigo et al., 2020; Petzold et al., 2023; Quintana-García & Benavides-Velasco, 2010, 2011; Wang et al., 2023), new studies that explore and discuss the direct influence of innovation ecosystems on portfolio balance are necessary to further understand the dynamic of radical innovation portfolio in organizations. Additionally, there is a gap in literature regarding how to specifically measure and monitor the performance of radical innovation portfolios. Thus, future research should describe the mechanisms and methods used by organizations to assess radical innovation projects against organizational expectations.

On the other hand, the relationship between strategic alignment and innovation portfolio sustainability is gaining traction. Resource allocation poses a critical challenge for organizations (Chao & Kavadias, 2008; Cooper, 2013; Ferras-Hernandez, 2023; Paulson et al., 2007; Petzold et al., 2023; Weinreich et al., 2022), and adopting a sustainability vision can enhance strategic alignment of innovation portfolios with organizational goals, especially in long term (Brook & Pagnanelli, 2014; Petzold et al., 2023). In this sense, project selection and prioritization should go beyond quantitative valuation, aiming to develop portfolios that are both sustainable and strategically aligned with the organization's long-term objectives, as in the case of the Pharmaceutical and Information Technology sectors (Haeckel et al., 2015; Park & Shin, 2018). However, as literature on sustainability mechanisms for radical innovation projects is scarce, future research could focus on exploring and proposing integrations with valuation mechanisms to improve the financial and strategic value of radical innovation portfolios.

As presented in the previous section, restrictive mental models pose a significant barrier to selecting radical innovation projects. This highlights the need for innovation management to improve existing mental models considering the new perspectives of the decision-making process, since existing models not only shape how benefits are perceived, but also influence strategies for mitigating risks associated with radical innovation (Lettice & Thomond, 2008), such as correlated with case studies that explore the decision-making dynamics of innovation portfolios across different economic sectors (Annosi et al., 2020; Wilden et al., 2023). However, a critical gap exists in understanding how mental models within organizations influence radical innovation project selection. Only three studies explicitly address this topic research (Heidary Dahooie et al., 2023; Hooge & Dalmasso, 2016; Lettice & Thomond, 2008), presenting a significant opportunity for future research. Moreover, existing research often focuses on a limited range of organizational hierarchies. This presents a future opportunity to explore how restrictive mental models impact decision-making across various levels and their influence on strategic innovation portfolio alignment.

Finally, valuation methods and project legitimacy are prominent subjects in current research. Despite extensive discourse, practical application and adaptability of these methods for radical innovation projects remain uncertain (Castro et al., 2020; Flechas Chaparro et al., 2019; Heidary Dahooie et al., 2023; Petzold et al., 2023; Weinreich et al., 2022). However, there is limited documentation and discussions regarding daily organizational practices. Therefore, new research describing and discussing organizational practices across different contexts and economic sectors is essential for debating this issue in the current literature.

6. Conclusion

The analyzed literature delineates seven critical dimensions in portfolio management of radical innovation projects. These dimensions encompass the influence of mental models on project selection, the integration between ideation and innovation portfolio, the direction of balancing and budget, the strategic alignment and portfolio sustainability, the legitimacy of projects and valuation methods, the portfolio performance, and the portfolio of partnerships and alliances. The findings contribute to theoretical framework by systematically

discussing models and approaches for managing portfolios of radical innovation projects. This highlights potential research gaps and future opportunities. These insights offer a comprehensive perspective on potential management approaches, providing valuable information for practitioners.

However, this study acknowledges certain limitations. The research was conducted using a single scientific database, using only peer-reviewed journal articles. Future reviews could consider expanding scope by including additional databases and different types of academic work. Furthermore, content analysis process is inherently subjective, dependent on authors' interpretation, which may pose challenges in replicating results, despite the systematic execution of process.

Despite these limitations, this review sheds light on multifaceted nature of managing radical innovation project portfolios. By identifying seven critical dimensions and discussing relevant models and approaches, this review offers a valuable foundation for both academics and practitioners. Future research can build upon this framework by exploring the identified gaps and expanding the scope of investigation.

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