

Innovation Portfolio Management for the public non-profit research and development sector: What can we learn from the private sector?

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Abstract

Innovation Portfolio Management refers to the systems, processes, and mechanisms to intentionally manage innovation investments and decisions within an organisation against its mission or strategy. This approach to managing and optimizing innovation and scaling investments is rarely used by public non-profit R&D organizations. This study draws lessons from innovation portfolio management in private sector organizations. Private sector invest in innovation portfolio management to: (i) enhance transparent and evidence-based decision-making, (ii) strengthen organizational agility and mission-orientedness, (iii) facilitate monitoring, risk management and prioritization, and (iv) improve overall organizational performance and learning. These innovation portfolio management benefits are equally relevant for the public non-profit R&D sector, where innovation performance and outcomes are for societal impact. Public non-profit R&D can and should manage their innovation portfolios more intentionally, and can learn from private sector successes and challenges. Embracing the opportunities, whilst managing the challenges and risks requires investment in methods, mechanisms and mindsets for effective innovation portfolio management.

Keywords

Sustainable Development Goals; Innovation Systems; Impact; International Development; Stage-gating; End-to-End Innovation Management.

46 **Highlights**

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- 48 • Private sector organizations invest in innovation portfolio management
- 49 • Few public sector organizations purposefully manage their innovation portfolios
- 50 • Public non-profit R&D sector can benefit from innovation portfolio management
- 51 • Clarity on innovation portfolio intent and resource allocation strategy are key
- 52 • Innovation portfolio management can support impact culture growth

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1. Introduction

1.1 Public non-profit research and development

Over the past years, innovation has slowly but steadily found its way into the international sustainable development discourse and practice (Silva, 2021). Fueled by an implicit belief that innovation can solve international development problems, there is increasing pressure on public non-profit research and development (R&D) organizations to demonstrate how investments in science and innovation contribute to addressing global challenges such as those formulated under the United Nation's Sustainable Development Goals (Penfield et al., 2014; Glover et al., 2016; Leeuwis et al., 2018). On the one hand, this triggered a debate on how to better allocate, manage and monitor public non-profit R&D investments (Schut et al., 2020). On the other hand, it has tempted organizations to over-promise and to focus on *hypes* and *quick wins* over investments in sustainable transformations along realistic impact pathways (Hall and Dijkman, 2019; Kumpf and Proud, 2022).

Public non-profit R&D can be defined as the research and development activities conducted by public sector organizations (governments and non-governmental) whose primary mandate is develop and deliver innovation through public policy and market-shaping without having the objective to make profit (Chen et al., 2020; Silva, 2021). Public non-profit R&D is an important driver of innovation in sectors such as agriculture, education, nutrition and health, especially in low- and middle-income countries. The sector can be further characterized in a number of ways. First, a significant portion of public non-profit R&D receives its funding from national governments, next to investments made by international

financial organizations (e.g., World Bank), philanthropical organizations (e.g., Bill and Melinda Gates Foundation), companies and their foundations (e.g., MasterCard Foundation), and collectives of governments (e.g., the European Union). Second, the core business of public non-profit R&D is to design, test, validate and support uptake of innovations. In most cases, funders expect that grants and investments contribute to positive societal impact. Third, the results, outputs or innovations that are being developed are generally intended to serve the public interest rather than to generate profits. In some cases, the innovations are considered ‘public goods’ – available to all members of a society in an open and non-exclusive manner (Oakland, 1987). In other cases, innovations are ‘proprietary’ – protected by intellectual property rights or commercial exclusivity agreements.

1.2 Innovation and Innovation Portfolio Management

Innovations are generally defined as new or improved products, processes and services, or policy and institutional arrangements that intend to produce value (Nagji and Tuff, 2012). Innovations can be technological or non-technological in nature (Geldes et al., 2017), and can be at different stages of readiness, ranging from ideas to ready for deployment at scale (Evans and Johnson, 2013; Sartas et al., 2020). The use of innovation in society depends to a large extent on the existence or absence of an enabling environment (e.g., policy, infrastructure and market conditions) that influences whether or not people are aware of, have access to, can afford, or effectively use and benefit from the innovation. This is at the heart of recent publications that stress the importance of innovation packaging (Sartas et al., 2020; Schut et al., 2020) or socio-technical bundling (Barrett et al., 2022) for innovations

103 to lead to sustainable desired impact. Not all innovations will end up changing the world.
104 Many innovative ideas will not survive testing in un-controlled environments where real-life
105 political or market pressures determine whether or not innovations can contribute to
106 impact. Decision-making on which innovations to prioritize, pause or stop is a challenging
107 (Mathews, 2013), but essential part of performance and results management in R&D
108 organizations (Klingebiel and Rammer, 2014).

109

110 Most public non-profit R&D organizations manage not just one, but a broad variety of
111 innovations, innovation projects and interventions aimed at delivering (positive) societal
112 impact at scale. Innovation Portfolio Management refers to the systems, processes, and
113 mechanisms to intentionally manage and optimize organizational innovation investments
114 and decisions against its vision and strategy (Proud et al., 2023)¹. With increasing pressure
115 by funders to show progress towards development impact (Renkow and Byerlee, 2010;
116 Woltering et al., 2019), purposefully managing innovation investments is seen as *best*
117 *practice* for strengthening organizational effectiveness and performance (OPSI, 2022).
118 Several large public non-profit R&D organizations have embraced innovation portfolio
119 management as part of their organizational vision and mission, including CGIAR – a global
120 research partnership for agricultural research and innovation (Schut et al., 2024). Also
121 scientifically, there is a growing body of literature that focuses on impact-oriented research
122 and innovation in the public sector. This includes debates on mission-oriented agricultural
123 innovation systems (Klerkx and Begemann, 2020), system transformation (Leeuwis et al.,

¹ *Innovation portfolio management takes an organisational approach to managing innovations and is distinct from mission-driven or systemic innovation portfolio approaches that combine the interventions of multiple organisations towards a shared mission or intent.*

2021), responsible innovation (Stilgoe et al., 2013), and science of innovation scaling (Schut et al., 2020). Research on innovation portfolio management in the public sector aligns particularly well with more action-oriented system approaches to innovation that aim at finding the right balance between understanding and analysing innovation system complexity on the one hand and informing intervention and action on the other hand.

Although the practice and scientific attention for innovation portfolio management in the public non-profit sector has recently picked up (e.g. Holden et al., 2018; Megersa, 2019; Barrett et al., 2022), the vast majority of innovation portfolio management experiences come from the private sector (e.g. Mathews, 2013). Consistent project thinking being dominant in public sector, innovation portfolio management has received insufficient attention in the public non-profit innovation and development literature (Behrens, 2016; Holden et al., 2018; Megersa, 2019). The increased interest and discussion on how to operationalize innovation portfolio management in the public non-profit sector created the starting point for this study.

1.3 Study objectives

The objective of this study is to draw lessons from innovation portfolio management in the private sector, and to explore how these can inform innovation portfolio management in the public non-profit sector. The study is guided by three questions (1) What are the main reasons why organisations invest in innovation portfolio management? (2) What are success factors for innovation portfolio management? (3) What are challenges for innovation portfolio management?

2. Materials and Methods

The academic debate on innovation portfolio management in the private sector forms the main source of analysis in this paper. We explored databases Google Scholar, Emerald, ScienceDirect, Springer, and Taylor and Francis for “innovation portfolio management” in their title, abstract and other searchable fields. We then screened the publications for the following characteristics (i) whether the article was published in English language, (ii) whether the publication is published in a peer-reviewed international journal, (iii) whether innovation portfolio management is well emphasized (mentioned >5 times), and (iv) whether the study was published after 2011 to ensure its relevance. Initially, 53 publications were retrieved, of which 38 publications were excluded, remaining with 15 publications that provided our entry point for analysis (Table 1). Using a snowball approach, this initial set of publications allowed us to identify other publications on innovation portfolio management in the private sector, as well as a special issue in the Journal of Research-Technology Management on the topic (Mathews, 2013).

Table 1. Overview of the 15 publications that provided the entry point for the study.

Citation (in alphabetic order)	Online access (URL)	Sector	Paper Type	Open Access (Y/N)
Behrens, J., 2016. A lack of insight: an experimental analysis of R&D managers' decision making in innovation portfolio management. Creativity and Innovation Management 25, no. 2: 239-250.	https://onlinelibrary.wiley.com/doi/abs/10.1111/caim.12157	Cross-industry	Empirical	N

Brook, J. W., and F. Pagnanelli, 2014. Integrating sustainability into innovation project portfolio management—A strategic perspective. <i>Journal of Engineering and Technology Management</i> 34: 46-62.	https://www.sciencedirect.com/science/article/pii/S0923474813000830	Automation industry	Empirical	N
Holtzman, Y., 2014. A strategy of innovation through the development of a portfolio of innovation capabilities. <i>Journal of Management Development</i> 33, no. 1: 24-31.	https://www.emerald.com/insight/content/doi/10.1108/JMD-11-2013-0138/full/html	Innovation, new product development, and research & development industries	Empirical	N
Huvaj, M. N., and W.C. Johnson, 2019. Organizational complexity and innovation portfolio decisions: Evidence from a quasi-natural experiment. <i>Journal of Business Research</i> 98: 153-165.	https://www.sciencedirect.com/science/article/abs/pii/S0148296318306660	Medical device industry	Empirical	N
Klingebiel, R. and C. Rammer, 2014. Resource allocation strategy for innovation portfolio management. <i>Strategic Management Journal</i> 35, no. 2: 246-268.	https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.2107	Cross-industry	Empirical	N
Kock, A., and H. G. Gemünden, 2016a. Antecedents to decision-making quality and agility in innovation portfolio management. <i>Journal of Product Innovation Management</i> 33, no. 6: 670-686.	https://onlinelibrary.wiley.com/doi/abs/10.1111/jpim.12336	Cross-industry	Empirical	N
Kock, A., and H. G. Gemünden, 2016b. How strategic orientation moderates the relationship between innovation portfolio management and success. In <i>R&D Management Conference 2016: From Science to Society: Innovation and Value Creation</i> Cambridge, UK: 1-14.	Retrieved from the authors' private ResearchGate repository	Cross-industry	Empirical	Y
Martinsuo, M., and L. Vuorinen, 2019. Uncertainties and dynamics in the practice of innovation project portfolio management. In <i>Proceedings of the 26th Innovation and Product Development Management Conference</i> . European Institute for Advanced Studies in Management, EIASM, 2019.	https://trepo.tuni.fi/handle/10024/135967	Construction and software industries	Empirical	Y
Pashley, D., T. Tryfonas, A. Crossley, C. Setchell, and S. Karatzas, 2020. Innovation Portfolio Management for	https://link.springer.com/article	Software development industry	Empirical	N

Small-medium Enterprises. Journal of Systems Science and Systems Engineering 29, no. 5: 507-524.	e/10.1007/s11518-020-5467-z			
Roeth, T., P. Spieth, and D. Lange, 2019. Managerial political behavior in innovation portfolio management: A sensegiving and sensebreaking process. Journal of Product Innovation Management 36, no. 5: 534-559.	https://onlinelibrary.wiley.com/doi/abs/10.1111/jpim.12501	Automation industry	Empirical	N
Sicotte, H., N. Drouin, and H. Delerue, 2014. Innovation portfolio management as a subset of dynamic capabilities: Measurement and impact on innovative performance. Project Management Journal 45, no. 6: 58-72.	https://journals.sagepub.com/doi/abs/10.1002/pmj.21456	Research and development industry	Empirical	N
Spieth, P., and M. Lerch, 2014. Augmenting innovation project portfolio management performance: the mediating effect of management perception and satisfaction. R&D Management 44, no. 5: 498-515.	https://onlinelibrary.wiley.com/doi/abs/10.1111/radm.12092	Cross-industry	Empirical	N
Toh, P. K., and G. Ahuja, 2022. Integration and appropriability: A study of process and product components within a firm's innovation portfolio. Strategic Management Journal 43, no. 6: 1075-1109.	https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.3351	Cross-industry	Empirical	N
Urhahn, C., and P. Spieth, 2014. Governing the portfolio management process for product innovation—A quantitative analysis on the relationship between portfolio management governance, portfolio innovativeness, and firm performance. IEEE Transactions on Engineering Management 61, no. 3: 522-533.	https://ieeexplore.ieee.org/abstract/document/6849434/	Cross-industry	Empirical	N
Üçler, Ç., 2018. Portfolio management for innovation ideas: weighing antecedents with AHP. Journal of Entrepreneurship and Innovation Management 7, no. 1: 25-52.	https://www.betadergi.com/jei/yonetim/icerik/makaleler/93-published.pdf	Innovation industry	Empirical	Y

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168 The analysis of the literature was guided by the three questions elaborated in Section 1.3.

169 After initial familiarization, we used a matrix approach to identify, structure and group key

170 (sub-)themes related to the three guiding questions. In many cases, reading the individual

publications supported us in snowballing and identifying additional literature on the topic. We applied the ‘principle of saturation’ to decide whether or not to identify and analyse additional literature on the (sub-)themes (Saunders et al., 2018). Further analysis focussed on identifying patterns across themes or publications, for example by identifying multiple publications referring to similar phenomena or reaching similar/ contradicting conclusions. When writing up the key results, we often went back to the publications to ensure we properly interpreted concepts and looked for examples to underpin our main conclusions.

3. Results

Innovation portfolio management is generally defined as a systematic approach to optimizing or aligning internal processes, resources, partnerships and performance to achieve organizational mission, vision and goals. There is strong consensus that innovation portfolio management improves decision-making in organizations and overall organizational performance.

From our initial scoping of the literature, several studies are cross-sectoral and focused on innovation portfolio management in manufacturing companies, high-tech companies, metal/steel companies, electrical companies, automotive, and the chemical/pharmaceutical industry (Spieth and Lerch, 2014; Urhahn and Spieth, 2014; Behrens, 2016; Kock and Gemünden, 2016; Kock and Gemünden, 2016). Five papers assess innovation portfolio management in German companies (Klingebiel and Rammer, 2014; Urhahn and Spieth, 2014; Kock and Gemünden, 2016; Röth et al., 2019). Whilst most studies focus on

innovation portfolio management in larger commercial companies, Pashley et al. (2020) explored innovation structure framework in small and medium enterprises. Martinsuo and Vuorinen (2019) compared innovation portfolio management in project-based construction and software companies. Studies that were identified through snowball sampling focused on decision-making or stage-gating for portfolio diversity and health and drew from a broader variety of company experiences.

3.1. Main reasons why organizations invest in innovation portfolio management

Enhance transparent and quality decision-making

Adopting a systematized process for innovation management will lead to repeatable and trustworthy decision-making process (Spieth and Lerch, 2014; Kock and Gemünden, 2016; Röth et al., 2019; Pashley et al., 2020). Szutowski, Szulczewska-Remi, and Ratajczak (2019) found that traceability, reproducibility, and formalized procedures are critical factors for improved innovation performance and to distinguish innovations that continuously show positive results and thus impact potential from those that do not. This is also referred to as stage-gating (Cooper, 2008), where an organization defines stages, gates, and gate assessment criteria to manage of innovation development and deployment progress. Innovation portfolio management should be integrated in reporting mechanisms and aligned with the strategic management and decision-making agendas of senior managers or executive leaders of the organisation (Holtzman, 2014; Spieth and Lerch, 2014).

Strengthen organizational agility and mission-orientedness

217 Improved agility is the second theme that emerged. Several studies mentioned that formal
218 monitoring of innovation portfolios increases the agility of the organisation in making
219 strategic decisions (Brook and Pagnanelli, 2014; Kock and Gemünden, 2016; Martinsuo and
220 Vuorinen, 2019). Agility is being described as the adaptive nature of an organisation and
221 how they can respond to a changing, turbulent market or funding environment (Karvonen et
222 al., 2018). Agility allows organizations to respond to emerging opportunities, whilst using
223 the organizational mission as its compass (Attar and Abdul-Kareem, 2020). In addition, it
224 was shown that innovation portfolio management is used to align employees' capabilities
225 and innovation activities with the overall organisational mission (Spieth and Lerch, 2014;
226 Urhahn and Spieth, 2014; Martinsuo and Vuorinen, 2019; Röth et al., 2019).

227

228 ***Facilitate monitoring, risk management and prioritization***

229 Innovation portfolio management supports the tracking of innovation processes and
230 products in an organisation (Pashley et al., 2020). Several studies conclude that innovation
231 portfolio management is essential for monitoring and prioritizing of innovations in order to
232 understand which projects should be assigned resources, put on hold, or be discarded
233 (Holtzman, 2014; Urhahn and Spieth, 2014; Röth et al., 2019). Risk management that
234 defines and assesses different types of risks for each portfolio item plays a very important
235 part of this prioritization, and a balanced approach to risk should be taken (Holtzman, 2014).
236 Risk-Reward monitoring is mentioned in several studies as a key metric of innovation
237 portfolio management (Holden et al., 2018; Cooper and Sommer, 2023).

238

239 ***Improve organizational performance***

There seems to be consensus that innovation portfolio management increases organizational performance, value maximization and profitability, and competitive advantage (Holtzman, 2014; Klingebiel and Rammer, 2014; Sicotte et al., 2014; Spieth and Lerch, 2014; Behrens, 2016; Üçler, 2018; Toh and Ahuja, 2022). This is a result of improved organisational agility, learning and preparedness to align organizations to their everchanging environment (Cooper and Sommer, 2023). In addition, innovation portfolio management provides benefits with regards to planning investments against short, medium and long-term time horizons (Behrens, 2016; Toh and Ahuja, 2022). Although the performance benefits seem obvious, (Mathews, 2013) emphasizes that improving organizational performance to generate metrics and give meaning and value to (often chaotic) innovation development process is far from easy.

3.2. Success factors for innovation portfolio management

Fit-for-purpose systems to ensure timely access to quality information and metrics

Access to quality information, data and metrics is a key success factor for innovation portfolio management. Huvaj and Johnson (2019) state that innovation development processes should be measurable, both quantitatively and qualitatively. Innovation data can focus on tracking internal R&D, manufacturing, distributing processes, and cost information, as well as the broader innovation environment in a holistic way (Holtzman, 2014). This implies considering data about other competing or coopting organization, supply chains, customer needs and uptake. Beyond primary data also other metrics should be considered by organisations, including advanced pattern recognition (e.g., on client needs), mathematical

computer modelling (e.g., foresight of use potential or competition), and identifying and interpreting weak signals in the enabling environment (e.g., bottlenecks for innovation use).

To ensure that the information and metrics are of sufficient quality, timely and relevant, data collection structures and systems are essential (Urhahn and Spieth, 2014; Üçler, 2018). Such structures and systems are often referred to as innovation management systems (Üçler, 2018). An innovation management system is a specific type of information system that includes procedures and governance mechanisms designed towards achieving a particular organizational mission (Dzwigol et al., 2019). Innovation portfolio management systems define the roles and responsibilities of the various actors involved in innovation portfolio management, as well as the processes and governance mechanisms for innovation portfolio management decision-making (Röth et al., 2019). Studies by Röth et al. (2019) and Urhahn and Spieth (2014) show that formalized innovation portfolio management systems lead to better organizational performance and innovation outcomes. As part of strategic decision-making, innovation data collected through formal systems and procedures needs to be complemented by political sense-making and vision (Röth et al., 2019).

Clarity on innovation portfolio intent and related decision-making criteria

Innovation portfolio management requires making strategic decisions before innovation potential and outcomes can be fully validated. A key prerequisite for making such strategic decisions is having clarity on an organization's innovation portfolio intent (Klingebiel and Rammer, 2014), which refers to the overall organizational vision, mission and goals associated with the portfolio of innovations (Proud et al., 2023). Clarity on the specific portfolio objectives and outcomes (what to achieve) needs to go hand in hand with clarity

on the path to reach those objectives and outcomes (how to achieve). This may include an organizational vision on risk-reward and related investment in incremental innovations (lower risk), and investment in radical or disruptive innovations (higher risk) (Cooper, 2013; Pashley et al., 2020). Another example is to have clarity on key client-groups and markets, which may influence which type of innovations are prioritized.

Simply setting the goal is not enough; goals must be supported by clear criteria for decision-making and transparent resource allocation strategies (Cooper, 2013). Decision-making criteria need to be aligned to the organizational mission and innovation portfolio intent. For example, if an organization values sustainable development, then sustainability criteria should be able to guide decision making on the portfolio, ie. which innovations have a higher/lower likelihood to contribute to ecological, social and or economic sustainability (Brook and Pagnanelli, 2014). Criteria support innovation portfolio managers in making strategic decisions about the quality and quantity of financial and human resource allocation at successive points along an innovation pathway or process (Klingebiel and Rammer, 2014). Criteria for strategizing and decision making are important and can include harder criteria (e.g., return on investment, technological uncertainty, consumer demand) as well as softer criteria (e.g., opinions, company identity and reputation, management support) when allocating resources (Behrens, 2016). Innovation portfolio managers should have a basic level of understanding of the innovations and organizational innovation processes as this will influence their ability to interpret and judge innovation data and criteria (Röth et al., 2019).

310 Klingebiel and Rammer (2014) describe how criteria resource allocation strategies can
311 change along the innovation pipeline, focusing on breadth of innovations at early stages
312 (invest less resources in more innovations), and being more selective during later stages
313 (invest more resources in less innovations). It emphasizes the need to be specific about
314 pipeline stages, characteristics, gates and gate criteria to influence which innovations are
315 advancing or put on hold.

316

317 It is important to mention that every set of criteria and resource allocation strategy comes
318 with advantages and disadvantages. For example, prioritizing portfolio breadth in early
319 stage innovation can ‘starve’ individual innovation of sufficient resourcing, increase
320 managerial complexity and hamper strategic focus (Klingebiel and Rammer, 2014).

321

322 ***Invest in organizational innovation culture and capacity growth***

323 Innovation portfolio management often goes hand in hand with organizational innovation
324 culture change. Holtzman (2014) identifies five key organizational culture growth aspects in
325 relation to innovation portfolio management:

326 1. Create an innovation mindset – put innovation at the heart of the business and
327 foster a culture in which ideas are allowed to flourish;

328 2. Nurture creativity – support active experimentation, failure and learning as part of
329 the innovation journey;

330 3. Prepare the path to profit – collectively define success and what a fruitful outcome
331 looks like;

332 4. Match the metrics to different stages of innovation – allow innovative ideas space to
333 breath while also providing a structured approach for more mature innovations;

5. Take a balanced view on innovation risks – ensure a healthy mix of innovations and tie this back to nurturing innovation mindsets to encourage employees to innovate in diverse ways.

Managing changes that are associated with a different approach to managing innovation in an organisation is essential. Such innovation culture change should be mandated and nurtured by senior leadership in word and action. A fundamental building block for this is to formally integrating innovation into the strategic management agenda of senior leaders will ensure that innovation will not only be actively encouraged but also actively managed, tracked and measured (Holtzman, 2014). Having the right culture and climate is as important as having the right metrics (Cooper, 2013).

Employees are expected to acquire new knowledge and skills that will enhance innovation portfolio management (Sicotte et al., 2014). Actively investing in and managing organizational innovation capabilities is as important as managing the actual products, services and other types of innovation that those capabilities eventually result in. Several studies mentioned that employees should be involved in innovation portfolio management, as this builds trust of the employees and makes them part of the system and the decision-making processes related to it (Holtzman, 2014).

3.3. Challenges for innovation portfolio management

Data and information gaps and inappropriate decision-making criteria

357 Inadequate internal or external data and information to support decision making is a
358 challenge for innovation portfolio management (Kock and Gemünden, 2016). Information,
359 evidence and knowledge gaps can be both related to the innovation itself (Röth et al., 2019),
360 as well as to the market or political environment in which these innovations are expected to
361 be used (Kock and Gemünden, 2016; Huvaj and Johnson, 2019). Klingebiel and Rammer
362 (2014) add that such uncertainties influence the ability of managers, no matter how
363 intelligent or experienced, to confidently predict key determinants of innovation success. It
364 implies that organizations need to accept the risk of misjudging innovation's success
365 potential. Innovations that look promising may ultimately fail, whereas innovations that
366 seem unconvincing at first may eventually succeed (Klingebiel and Rammer, 2014).

367

368 Challenges related to innovation portfolio management systems and tools include the
369 absence or inappropriateness of innovation selection and appraisal criteria, difficulty in
370 designing methodology for measuring specific criteria, and the lack of a clearly defined
371 process that deals with the dynamic nature of innovation (Brook and Pagnanelli, 2014;
372 Spieth and Lerch, 2014). Managing a portfolio of innovations by – for example – only
373 assessing financial criteria (e.g., return on investment, profitability) may lead to favoring
374 low-risk innovations being advanced (Cooper, 2013). This can lock organizations into a cycle
375 of investing only in the ideas of least risk (incremental over radical innovation) which limits
376 the organization's growth and impact potential (Üçler, 2018; Huvaj and Johnson, 2019;
377 Pashley et al., 2020). Having a clear resource allocation strategy and balanced set of
378 decision-making criteria can avoid such organizational lock-in (Klingebiel and Rammer,
379 2014). Assessing innovations against multiple financial, strategic and social dimensions is
380 essential (Behrens, 2016; Röth et al., 2019; Cooper and Sommer, 2023), as well as valuing

381 managers' experiences, strategic foresight and networks in making strategic innovation
382 portfolio decisions (Pashley et al., 2020).

383

384 There exist different views on criteria related to managing internal and external innovation
385 interdependencies across innovations in a portfolio. Roth *et al.* (2019) emphasize that
386 interdependencies should be avoided as they reduce the chances of terminating individual
387 innovation projects. Meanwhile, Sicotte *et al.* (2014) shown that innovations often emerge
388 from an organization's capacity to integrate different types of dispersed knowledge, for
389 example technological and market knowledge.

390

391 ***Organizational fear of taking risk and failure***

392 Innovation and risk are two sides of the same coin, and – depending on the innovation
393 portfolio intent and criteria – risk management could easily stifle innovation (Holtzman,
394 2014). Innovation portfolio management should encourage innovative behavior, such as risk
395 taking, openness to new ideas, failure and learning. Rewarding short-term performance and
396 maintaining a fear of failure do not contribute to an environment that encourages radical
397 and disruptive innovation (Pashley et al., 2020). Progressive companies recognize that the
398 best concepts are often the most fragile ones, and that nurturing and not 'killing' them too
399 early is essential for breakthrough innovation (Cooper, 2013).

400

401 Taking a balanced approach to innovation risk, and having clarity on the resource allocation
402 strategy can overcome this fear. For example, investing broadly in early-stage innovations
403 goes hand-in-hand with an expectation that only 10% of these innovations will mature and
404 contribute to the organizational objectives and outcomes; implying that 90% should fail and

405 be killed along the way (Klingebiel and Rammer, 2014). An open risk climate and transparent
406 communication about risks are essential for innovation and innovation portfolio
407 management (Kock and Gemünden, 2016). Failure should be appreciated and evaluated and
408 widely communicated; what has been learned and what capability has perhaps been
409 developed or enhanced. Learning should be stimulated in a way that does not discourage
410 experimenting and penalize individuals and teams for failure (Holtzman, 2014).

411

412 ***Organizational resistance to innovation portfolio management***

413 For many, the systematized management of the creative process of innovation development
414 feels counter intuitive. Yet, having a well-balanced portfolio is important to achieve an
415 organizational mission and impacts (Nagji and Tuff, 2012). It is good to realize that
416 innovation portfolio management is not necessarily embraced by the entire organization,
417 and moreover can be costly and time consuming.

418

419 Reasons for resistance are often related to the criteria and resource allocation strategies.
420 Decisions to withdraw resources from early-stage innovations that seem less promising are
421 error-prone and will have consequences for the employees and partners working on those
422 innovations (Klingebiel and Rammer, 2014). Innovation developers may not agree with the
423 portfolio manager's decision which may demotivate, dissolve innovation networks, and
424 imply reassignment of employees to other innovation projects. In addition, employees may
425 feel that innovation *start-stop* processes undermines R&D processes, increases transaction
426 costs, and compromise strategic visioning and organizational planning (Spieth and Lerch,
427 2014; Kock and Gemünden, 2016; Üçler, 2018).

428

Holtzman (2014) mentions that putting innovation at the heart of the organization may result in a clash of cultures between those responsible for developing innovations, and those managing innovations. Innovation portfolio management inherently implies change and trade-offs. Managing such sensitivities requires transparency, strategy and clear rules of the game, whilst not losing touch of human side and implications of innovation portfolio management.

4. Discussion

In this section we reflect on the main private sector reasons, success factors and challenges and discuss the extent to which key observations are relevant for innovation portfolio management in the public non-profit R&D sector.

Benefit of innovation portfolio management in the public sector

Public organizations are generally underdeveloped in innovation portfolio management (Megersa, 2019; OECD, 2020) which limits or even negatively affects their impact potential. Especially for larger public non-profit R&D organizations the benefits seem obvious, though few have adopted an innovation portfolio management approach (Holden et al., 2018).

The key reasons of why private sector organizations invest in innovation portfolio management seem equally relevant for the public non-profit R&D sector. Similar to the private sector, public non-profit R&D operates in an unpredictable environment where resources are scarce, and making well-informed and transparent resource allocation

decisions is important. Public non-profit R&D often has a very clear mission and innovation portfolio management can improve how organizations monitor and learn, manage risks, and prioritize investments against that mission (Urhahn and Spieth, 2014; Üçler, 2018). Having a systematic approach to innovation management can improve credibility and trust for both internal stakeholders (the researchers and innovators) as well as for external stakeholders (funders and partners).

The key private sector success factors and challenges identified apply to the public sector as well. Having clarity about different purposes of innovation along with clear metrics and monitoring mechanisms, having timely access to information, defining appropriate hard and soft criteria for decision-making, and a transparent process to guide innovation portfolio management is perhaps even more important in the public sector where accountability and traceability of investments made by funders is key (Behrens, 2016).

There are some key differences between the private for-profit R&D and public non-profit R&D sectors in relation to innovation portfolio management are elaborated below.

Collaboration, integration and partnerships for innovation

Different views exist on whether and how to manage (knowledge) internal and external interdependencies across innovations in a portfolio. Roth *et al.* (2019) emphasize that interdependencies provide a risk as they reduce the chance of terminating individual innovation projects (see also: Khanna et al., 2018). In the private sector, organizational innovation competition is perceived as a way to manage uncertainty in innovation portfolios (Martinsuo and Vuorinen, 2019). Intentional investments in parallel, competing solutions for

476 the same challenge, and managing this competition, is a rather well-established risk
477 management strategy. The dominant majority of global development challenges (such as
478 climate change or biodiversity losses) that public non-profit organizations seek to tackle are
479 incredibly complex. These challenges are multi-dimensional and -disciplinary, cut across
480 multiple sectors, and can therefore not be neatly boxed (Hall and Clark, 2010). As a result,
481 innovation to address such global challenges often emerges from an organization's capacity
482 to integrate different types of dispersed knowledge and skills.

483

484 An external perspective on collaboration, integration and partnerships refers to the
485 collaboration between the different divisions within the R&D organization and how they can
486 be incentivized to closely work together to – one – try to understand the nature of the
487 challenge, and – two – come up with innovations that could tackle such problems. Different
488 types of innovations can be explored and tested, but here collaboration rather than
489 competition seems key. An external perspective on collaboration, integration and
490 partnerships refers to the collaboration between the public non-profit R&D organization
491 and other ecosystem players such as private companies and governments. For example,
492 whether or not a public non-profit R&D organization reaches its intended clients and
493 mission (e.g., farmers adopting a drought-tolerant variety) depends on collaboration
494 between research organizations (e.g., developing a new crop variety), governments (e.g.,
495 licensing the crop variety and allowing it to be released), the public extension system (e.g.,
496 promoting the new crop variety), and the private sector (e.g., providing a market). In this
497 situation, no one single organization could fulfill its mandate without working together,
498 which creates interdependencies and incentivizes collaboration, integration and
499 partnerships for innovation.

500

501 Such high levels of interdependencies indeed come with increased complexity and
502 coordination costs and make it more difficult to stop innovations of low potential, as well as
503 create ownership or intellectual property issues (Toh and Ahuja, 2022). Furthermore,
504 conflicting organizational objectives and perceptions on exclusivity and may compromise
505 public-private-partnerships for the development and deployment of public goods (Batjargal
506 and Zhang, 2021). To manage those and other challenges, the emerging field of ‘innovation
507 portfolio approaches’ is gaining traction as it seeks to overcome fragmentation and silos in
508 the innovation ecosystem by introducing directionality, reflexivity, coordination and
509 investments (Hanson and Bleckenwegner, 2021). The emerging body of literature on ‘open
510 innovation’ that shows how innovation processes can benefit from dismantling
511 organizational knowledge boundaries both in the public and private sectors (Lifshitz-Assaf,
512 2018; Beck et al., 2022).

513

514 **Agility versus strategic long-term R&D**

515 Ongoing responses to changes and innovation *start-stop* culture increases transaction costs
516 and compromises strategic visioning and organizational planning (Spieth and Lerch, 2014;
517 Kock and Gemünden, 2016; Üçler, 2018). Though agility is often presented as good practice,
518 it may be perceived as focusing on *quick wins* and addressing immediate needs, over
519 investment in strategic long-term transformation agendas and pathways, which is a core
520 mandate of many public non-profit R&D organizations. Furthermore, much of the v
521 innovation design and testing requires longer time horizons. For example, testing a new
522 crop variety may easily require two growing seasons which – depending on the crop – may
523 easily take up to 2 years. Investing in tech-enabled solutions and other innovations with a

vision to scale requires planning in time horizons that go beyond typical donor-funded project durations of approximately two to four years, that moreover come with limited flexibility to diverge from the project goals, even if the progressive insights, learning or changing societal demands may require so. A study on community-driven development initiatives found that “a phased program spread over perhaps 10-15 years may be the best course” for innovations to mature from idea to scalable solution (Binswanger and Azyar, 2003). A World Bank study specifically in the context of scaling up rural development programs indicates even somewhat longer scaling periods, totaling to 25-30 years (World Bank, 2003).

When making decisions on the design of innovation portfolio management structures, criteria and governance, organizations should consider what kind of review frequency and standard operation procedures align with both the short-term organizational goals, as well as medium- to long-term strategic vision and mission. For many public non-profit sector innovation portfolios, considerations on expectations of stakeholders, particularly funders, with regards to observability and tracking of concrete results will play an important role. As a result, public sector portfolio managers might decide to invest significant resources in interventions that can produce measurable results in shorter time frames. Here again, being transparent about innovation portfolio ambition and intent, and having transparent decision-making criteria and the resource allocation strategies may offer a solution, as it can ensure stability in strategic direction and ultimate goals, as well as agility in the navigation towards those stable objectives.

Organizational innovation cultures

548 Innovation portfolio management goes hand in hand with organizational innovation culture
549 change or growth. Innovation portfolio management seeks to strengthen strategic clarity,
550 process formality and transparency, quality control mechanisms, an innovative environment
551 for learning, and a risk-conscious climate to allow an organization to make better-informed
552 decisions on which innovations have the highest impact potential (Kock and Gemünden,
553 2016). In many public non-profit R&D organizations this will be experienced as a big change
554 that may go against employees' intuitions that innovation is a 'process' that should not be
555 'managed'. The assessment or decision to stop or 'kill' an innovation that they have
556 dedicated much of their career is something that employees could struggle with and that
557 needs to be handled with care. Work by Lifshitz-Assaf (2018) at NASA shows that R&D
558 professionals who receive refocusing coaching or capacity development are more successful
559 in embracing novel innovation management approaches.

560

561 Innovation portfolio management seeks to bring greater balance between the support of
562 new ideas, and the continuous incremental improvement and scaling of existing innovations
563 (Kumpf and Proud, 2022). Traditionally, public R&D employees might focus more on novelty
564 and testing new ideas, and be less equipped or interested in supporting the scaling of these
565 innovations with partners. An additional complicating factor is that innovation portfolio
566 management will be influenced or even driven by external actors (such as funders), who
567 may prioritize investment in exciting novelty over increment innovation. Given the fact that
568 innovation portfolio management is currently far from being mainstreamed in the public
569 sector, resistance to change is realistic and needs to be acknowledged and managed
570 sensibly.

571

572 Innovation portfolio management is as much about organizational mindset change process
573 as it is about the operational methods, and mechanisms. It is essential to find the right
574 balance between expanding the organizational innovation cultural and mindset boundaries
575 on the one hand, whilst ensuring buy-in and support across organizational levels on the
576 other hand (Holtzman, 2014). What would be important is to demystify some innovation
577 portfolio management myths (e.g., that this increases top-down decision-making,
578 innovation cannot be measured), and emphasize its advantages (e.g., that it provides a
579 more transparent framework for risk management, that it can increase space for learning).

580

581 **Transition from established practices to explicit innovation portfolio management**

582 Transitioning from established practices to explicit innovation portfolio management is
583 undoubtedly a complex endeavour, regardless of organizational type. However, our
584 research sheds light on the challenges and success factors inherent in this process, offering
585 valuable guidance for those embarking on such transitions. Central to this is the formulation
586 of a clear and realistic roadmap for innovation portfolio management that is intricately
587 linked to the organization's overarching vision. Moreover, it is important to elucidate how
588 existing organizational practices present obstacles and risks, while articulating a clear
589 narrative on how innovation portfolio management will address these challenges. Key
590 components of a successful transition process include securing buy-in and support from
591 investors and leadership, fostering transparency regarding criteria, resource allocation
592 strategies, and governance, investing in cultural and capacity development as part of change
593 management efforts, and restructuring organizational incentive mechanisms to encourage
594 tolerance for innovation failure and prioritize portfolio performance and impact over
595 individual project achievements.

It is crucial to recognize that there are no universal solutions for transition processes, as each must be tailored to fit the unique vision and culture of the organization. Early case studies, such as that by Schut et al. (e.g. Schut et al., 2024) , offer valuable insights into the complexities and nuances of innovation portfolio management transitions within public non-profit R&D organizations.

Study limitations and future directions

We acknowledge that our literature review approach has limitations. An important limitation is that the search was conducted in English only. Another limitation is that our initial literature search was relatively un-structured. A more structured or systematic literature search (e.g. with more diverse search terms) would have resulted in a much larger sample of the literature. Nonetheless, we are confident that the study managed to identify the main reasons, successes and challenges for innovation portfolio management, which offers a crucial starting point for further studies to dive deeper into the specific results and conclusions.

(Huvaj and Johnson, 2019; Schut et al., 2024)

5. Conclusions and outlook

Allocating scarce resources to innovation endeavors is a daunting task for many organizational decision makers in both the private and public R&D sector. While many public non-profit R&D organizations refer to innovation as being part of their core business, few explicitly lead and manage their portfolios intentionally, and ad hoc innovation management still prevails over more systematic innovation portfolio management.

620 Private sector organizations invest in innovation portfolio management to: (i) enhance
621 transparent and quality decision-making, (ii) strengthen organizational agility and mission-
622 orientedness, (iii) facilitate monitoring, risk management and prioritization, and (iv) improve
623 overall organizational performance. These reasons are equally important to the public non-
624 profit R&D sector. Success factors for portfolio management include (i) developing fit-for-
625 purpose systems to ensure timely access to quality information and metrics, (ii) having
626 clarity on innovation portfolio intent and related decision-making criteria, and (iii) investing
627 in organizational innovation culture growth and capacity. The main challenges include: (i)
628 data and information gaps and inappropriate decision-making criteria, (ii) organizational
629 fear of taking risk and failure, and (iii) organizational resistance to innovation portfolio
630 management.

631

632 For innovation portfolio management to succeed in the public non-profit R&D sector it is
633 important to acknowledge some key similarities and differences compared to the private
634 sector. Similarities are related to the importance of having clarity on the organization
635 innovation portfolio intent and having transparent hard and soft criteria and resource
636 allocation strategies to ensure a healthy and diverse innovation portfolio that delivers
637 against the short- and long-term organizational mission. Differences can be found in the
638 importance of internal collaboration and external partnerships for innovation to address
639 complex or wicked global challenges; the incumbent organizational innovation cultures and
640 mindsets and how these are being reinforced by funders and incentive mechanisms; and
641 finally, the tension that may result from a focus on immediate needs and emergent
642 opportunities, over investment in strategic long-term transformation agendas and
643 pathways.

644

645 There are no *plug-and-play* solutions for innovation portfolio management in the public
646 non-profit R&D sector. Innovation portfolio management is as much about putting in place
647 methods (systems and tools to have timely access to quality data on innovation) and
648 mechanisms (incentives and decision-criteria to align the portfolio with the organisational
649 mission), as it is about growing the organizational capacities and mindsets (the underlying
650 cultural and capacity (change) dimension) in a transparent way that embodies trust and
651 confidence among employees and funders. What constitutes the right set of Methods,
652 Mechanisms and Mindsets will vary across organizations, and has to be tailored to their
653 mission, portfolio intent, and organizational culture.

654 **Declaration of interest**

655

656 The authors declare no financial or non-financial conflict of interest.

657

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659

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