Achieving Agility in IT Project Portfolios

Achieving Agility in IT Project Portfolios

– a systematic literature review

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Abstract.

Over the past two decades, enterprise IT functions have enjoyed continued success in projects using agile development methods. However, the lack of ample empirical research on achieving portfolio level agility can potentially inhibit their ability to effectively govern IT investments while scaling agile practices to derive more significant benefits. This study examines the impact of agile delivery efforts on project portfolio management at the enterprise level and identifies approaches adopted to foster agility in portfolio practices. We conducted a systematic literature review to explore existing scientific knowledge around agile methods and portfolio management in an enterprise IT context. An analysis of the 21 primary studies found relevant to this research identified six portfolio management aspects impacted by agile delivery practices and a variety of approaches adopted to support them. While these identified portfolio management aspects guide practitioners on areas to focus on while scaling agile efforts across an enterprise, the specific practices/approaches observed present opportunities to consider within their respective organizational contexts. Portfolio processes need an exploratory focus to sense environmental change to support agility, utilize a systems-thinking approach for a holistic view of potential interactions within and across portfolio components, and consider the effect of existing organizational processes to support portfolio agility. This study contributes to academic knowledge by synthesizing current knowledge on how portfolio management contributes to IT agility while incorporating agile delivery efforts and by identifying a set of future research directions in this space.

Keywords: agile methods, IT agility, portfolio management, systematic literature review

1 Introduction

Today's enterprises face increasing pressure from the complex dynamics of their markets, forcing them to critically examine their business models to stay ahead of their competition [1]. As a result, information technology (IT) capabilities are being called

on to enable options to drive business model innovation [2]. IT agility, the two-dimensional capability to sense and respond to changing IT environments, enables IT functions to influence their "*position to impact strategic business decisions*" [3]. Enterprise IT functions are increasingly adopting agile delivery practices leading to improved project delivery efficiency, product quality, stakeholder satisfaction, and project performance [4]. The success of agile methods has led enterprises to consider applying them at a larger scale, with support from several scaling frameworks introduced in the practitioner space to align these development efforts to business strategies.

There is extensive research on the use of agile methods to deliver project outcomes. In comparison, the investigation into scaling agile practices to the enterprise level has been less prevalent. Given that agile practices focus on shorter planning/delivery cycles that continually adapt to and align with evolving customer needs, portfolio management structures and processes need adjustments to preserve IT agility. Although portfolio management is considered a critical aspect of large-scale agile development [5], there is limited research conducted into the structures and processes supporting portfolio activities governing agile environments [6].

This literature review brings together our current understanding of how project portfolios enable IT agility while incorporating agile delivery efforts and is a unique contribution by being the first to explore the current state of knowledge at the intersection of portfolio management and agile practices. This review aims to understand better how enterprises can achieve agility in their IT portfolio management process. It identifies impacts on portfolio areas from agile delivery methods and describes approaches adopted to address these impacts. This review is part of a broader effort to design an agile portfolio management framework, and the review findings will form the basis for future studies on portfolio management practices enabling IT agility.

Section 2 of this paper provides a conceptual background to facilitate the literature review, and Section 3 describes the systematic literature review process. The review results in Section 4 present a set of themes crucial to achieving agility in IT portfolios. Section 5 discusses the implications of these findings, while Section 6 concludes by summarizing the contributions and calling out future research directions.

2 Background

This section explores key concepts in IT project portfolio management and agile software development principles to frame the literature review.

2.1 Project Portfolio Management

Levine [7] describes project portfolio management (PPM) as a set of practices binding traditional operations management and project management disciplines to ensure project contributions are maximized and aligned to enterprise success. PPM is the means to realize enterprise strategies [8] by screening, selecting, continuously prioritizing, and allocating resources to projects in line with strategic priorities [9]. Extensive research

conducted on portfolio practices across various enterprises [10] identified maximizing portfolio value, achieving a balance in the mix of projects, and ensuring alignment to business strategies as portfolio management's goals. Müller et al. [11] categorize PPM activities into three groups of top-down methods that (1) align projects with business strategy and prioritizes them (portfolio selection), (2) continuously monitor and communicate project priorities and progress at the portfolio-level (portfolio reporting) and (3) make rational and objective choices to accelerate, kill or reprioritize projects within the portfolio (portfolio decision-making).

McFarlan [12] suggested using the portfolio model to manage overall risk exposures for information technology (IT) projects in a manner analogous to applying the modern portfolio theory [13] to an investment portfolio of diversified financial securities. The US General Accounting Office [14] recommends a portfolio investment approach to select, control, and evaluate IT projects by defining and applying a set of decision criteria across benefits, costs, and risks associated with the competing project investment options. Maizlish and Handler [15] describe IT PPM as "a combination of people, processes, and corresponding information and technology that sensed and responded to change by reprioritizing/rebalancing investments and assets, value-based risk assessment of existing assets, eliminating redundancies while maximizing reuse, optimal resource allocation, and continuous monitoring & measuring."

Project portfolio management is an essential IT governance practice [16] to realize the expected business value from IT-enabled investments by aligning business objectives and IT strategies. A review of project governance literature [17] identifies two perspectives for project governance – an external system of governance that focuses on centralized monitoring and controls to ensure project outcomes stay aligned to strategic objectives and an internal one that builds organizational capabilities to achieve shared project goals. Kujala et al. [18] propose a framework to support project governance across six dimensions (goal setting, incentives, monitoring, coordination, decision-making, and capability building).

2.2 IT Agility and Agile Software Development

Leonhardt et al. [3] view IT agility as a capability that, on the one hand, proactively senses and assesses emergent developments and opportunities, and on the other hand, maintains an IT landscape that enables swift response and adaptation to the changing business needs. The 14th Annual State of Agile Survey indicates that enterprises adopt agile software development methods to accelerate their software delivery (71%), to enhance their ability to manage changing priorities (63%), and to increase productivity (51%) [19]. Agile methods, like Scrum [20] based on agile values/principles [21] and concepts of empirical process control, were conceptualized to improve the way software development projects are organized and executed.. They use iterative and incremental delivery of project results with self-organized cross-functional teams using patterns of actions like daily stand-up meetings for team coordination and frequent reviews with close customer contact [22]. Studies indicate that agile delivery methods positively

impact efficiency, stakeholder satisfaction, and perception of overall project performance [4] and reduce overall project delivery timelines [23].

2.3 Agile Portfolio Management

Agile portfolio management extends existing portfolio activities [11] by connecting agile software development teams to enterprise strategies allowing for rapid reconfigurations of portfolio components in response to changing environments, thereby enabling IT agility [3]. This view of applying agile principles to the portfolio level is consistent with Krebs' approach to dynamically manage portfolios using flexible financial models [24] or the Scaled Agile Framework's direction for lean portfolios [25]. Traditional portfolio management often takes a linear, top-down approach and focuses on long-term-planning and control [26], while agile principles highlight the need to be iterative and responsive to change [27]. There is a difference in the granularity of planning (informal vs. formal and *a priori* vs. evolutionary) within agile efforts [28], particularly while considering resource allocations, ranging from smaller projects to complex enterprise-level portfolios [29]. Elements like team autonomy and diversity advocated in agile methods indicate a people-centric approach [30] compared to the more resource-oriented view of traditional portfolio management.

An exploration of existing agile scaling frameworks, like the Scaled Agile Framework[1] (SAFe), Large Scale Scrum[2] (LeSS), and Disciplined Agile Delivery[3] (DAD), indicated little consistency in their recommendations to scale agile efforts to the portfolio level [6,31,32].

Table 1 lists literature reviews identified during the preliminary search relating to large-scale agile practices. Although none of these reviews directly address portfolio-level impacts while scaling agile practices, they provided relevant background information to identify themes for use during the data synthesis process.

Table 1. Past Literature Reviews identified

No.	Reference	Focus Area
1	Lappi et al. [33]	Mapping traditional governance practices to agile contexts using the project governance model proposed by Kujala et al. [18]
2	Alqudah and Razali [32]	Comparing the roles and practices of six common frameworks to scaling agile practices
3	Dikert et al. [34]	Identifying challenges/success factors for large-scale agile transformations
4	Ahmad et al. [35]	Explores the use of Kanban in support of software engineering practices

[1] See https://scaledagileframework.com for more details
[2] See https://less.works for more details
[3] See https://pmi.org/disciplined-agile for more details

3 Review Method

The aim of a literature review is "to map and to assess the existing intellectual territory", to incorporate a degree of rigor into the inquiry process, and to develop a comprehensive knowledge-base for practitioners from a range of past studies [36]. Established practices of conducting literature reviews in the information systems space [37,38] guide the protocols described in this section. The literature review protocol covers detailed research questions, identifying literature sources, search strategy, inclusion, exclusion, and quality assessment criteria, processes to extract and synthesize data from identified studies, and reporting findings.

The research objective to better understand how enterprises can achieve agility in their IT portfolio management process is addressed through two research questions that guide and direct the review.

RQ1 – How have agile software delivery methods impacted existing enterprise portfolio management practices
RQ2 – What approaches/practices have enterprises adopted to achieve agility in meeting portfolio objectives?

3.1 Inclusion and Exclusion Criteria

Based on the various aspects of inquiry derived from the research questions, **Table 2** provides guidance for inclusion and exclusion decisions for this review to ensure that only studies relevant to the research questions are selected.

Table 2. Inclusion and exclusion criteria

RQ Aspect	Inclusion examples	Exclusion examples
Portfolio Management	IT Portfolio Management; Governance of IT project investments; Multi-project practices	Financial securities, product/service portfolios; Focus on IT aspects like strategy & planning, architecture, process & performance, capabilities, culture
Agile	Lean/agile software development methods used in teams and product groups; Use of agile scaling frameworks	Agile manufacturing, contracting or supply chain practices; Descriptions of or experiences with specific agile methods
Enterprise IT Context	Multiple s/w dev teams, Solution delivery against business plans; Structures, and processes for project delivery	Individual or single team settings; Non-IT related business processes (e.g., training methods, business processes)
Empirical	Qualitative & quantitative studies; Peer-reviewed journal articles & conference papers	Conceptual papers, grey literature, vendor/analyst whitepapers, and other non-academic sources

3.2 Data Sources and Search Strategy

This study's topic cuts across research in information systems, computer science, software engineering, and project management. The search used six electronic databases – ACM Digital Library, AIS Electronic Library, IEEE Xplore, Elsevier ScienceDirect, Scopus, and Web of Science – to accommodate topics' breadth.

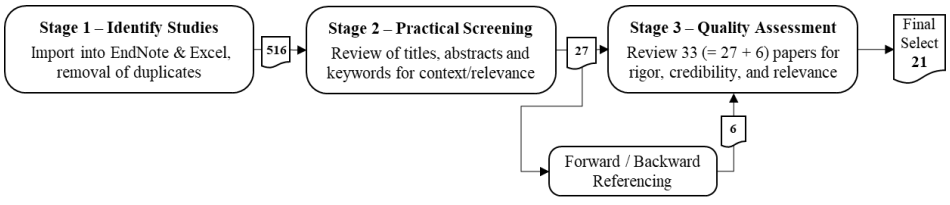
The preliminary search process used multiple combinations of terms for inclusion (like "*agile*," "*agility*," "*lean*," "*large scale*," "*enterprise*," "*governance*," "*scaling*," "*transformation*," "*portfolio*," "*project*," and "*software*") and exclusion (like "*manufacturing*," "*supply chain*," and "*contract*") to observe patterns and relevance in search outputs and to evolve suitable search criteria for the review. The final search string applied against the Title, Abstract, and Keywords in each database[4] is as follows:

> *"agile" AND "portfolio" AND ("software" OR "information" OR "governance" OR "scale" OR "lean")*

3.3 Study Selection Process

After removing duplicate results from the initial search (Stage 1), citations (n = 516) are loaded into an EndNote library. The metadata to support retrieval and inclusion decisions is maintained and tracked as review records in Microsoft Excel worksheets. The study selection process spans three stages, as shown in **Fig. 1**.

During Stage 2, the reviewer examined titles, abstracts, and keywords of each selected paper using the inclusion and exclusion criteria (described in **Table 2**) to establish their relevance to this review. After removing obvious exclusions (based on publication channels, research topics, and non-empirical papers), abstracts were scanned for factors such as domain under investigation (describing portfolio management in the contexts other than IT, like financial securities or product/service portfolios) and IS focus area (related to IT strategy & planning, IT architecture, IT processes, IT capabilities, culture, and performance instead of IT portfolio management or multi-project practices) to identify papers that need to be eliminated from the review process. There were 27 papers selected at the end of this second stage.



[4] The search string was implemented in the syntax unique to each database. Database searches were conducted in early June 2020.

Fig. 1. The multi-stage study selection process

The review employs a forward and backward snowballing process [39] using Google Scholar[5] to examine the citations and the references included in the 27 selected papers. This exercise identified six additional studies relevant to the topic that did not appear in the search process.

Stage 3 performs a detailed full-text review of the 33 selected papers (27 papers included from Stage 2 and six papers from the snowballing process) for their methodological rigor, the credibility of their results, and the relevance of their findings based on quality assessment criteria guided by recommendations from Kitchenham and Charters [37]. Of the six criteria identified, the first one ('*The research objective of this study is pertinent to the review*') is used to eliminate studies where the objectives do not map to the review's objectives. The other five criteria describe factors relating to rigor, credibility, and relevance of the studies and are scored on a 5-point Likert response format from 'Strongly Disagree' (1) to 'Strongly Agree' (5) based on each study's overall quality and strength of evidence. Studies with mean scores lower than 2.5 (indicating quality issues across most criteria) were removed from further review.

Based on the quality assessment results shown in **Table 3**, five studies were found irrelevant to the review. Seven studies of insufficient quality were eliminated, resulting in a final selection of 21 papers for further review.

Table 3. Quality Assessment Criteria and Results

No.	Criteria	Possible Responses	Results				
1	The research objective of this study is pertinent to the review	(0) No (1) Yes	0 ~~5~~	1 28	Five studies eliminated		
			1	2	3	4	5
2	The study describes its context in sufficient detail	(1) Strongly Disagree (2) Disagree (3) Neither Agree / Disagree (4) Agree (5) Strongly Agree	6	2	8	10	2
3	The research design addresses study objectives		7	5	8	5	3
4	The research methods are described with adequate clarity		8	3	9	6	2
5	The findings & results lead to justifiable conclusions		6	3	7	9	3
6	The study's outcomes contribute to knowledge or practice		4	3	9	8	4
Distribution of mean scores across Criteria 2 to 5 (papers with mean scores < 2.5 eliminated			~~6~~	~~1~~	13	6	2

3.4 Data Extraction and Synthesis of Findings

The final 21 studies selected for this review forms the input to the data extraction and thematic synthesis [40] stage. (see Appendix for the list of selected studies). The initial

[5] https://scholar.google.com

data extraction captured bibliographic (author, year, source, and type of publication) and contextual (the focus area, research objective, research design, study setting, data collection & analysis methods, findings, and conclusions) information for each paper into a structured Microsoft Excel spreadsheet. The EndNote library, including the associated full-text files, was imported into nVivo to perform content analysis.

Each study is coded in nVivo for its setting, theoretical basis, findings, and results using a set of code families based on the two research questions ('impact to portfolio practices' and 'approaches to support agile practices') and on concepts from the theoretical framework like portfolio management [10,11], agile principles [21] and project governance [33]. These codes were reviewed and organized to represent conceptual hierarchies that translated into themes.

3.5 Threats to Validity

We use factors such as internal validity, construct validity, external validity, and conclusion validity [41] to explore threats to this review's validity. Since this review aims to identify those portfolio management aspects impacted by agile delivery methods and not to determine any causal factors, threats relating to *internal validity* are considered irrelevant. Threats to *construct validity* relates to not having the right operational measures for the concepts under study. The study uses a formal review protocol created using well-accepted guidelines for literature reviews [37,38] and includes explicitly defined data collection methods with clear inclusion/exclusion criteria and data extraction process. The authors individually validated this review protocol to help ensure conceptual relevance and mitigate potential threats to construct validity.

This systematic approach to the review enables reproducibility and enhances the reliability of the review. It also makes the review context very visible and makes the findings from selected studies amenable for generalization (or *external validity*). Having incorrect search methods, inappropriate search terms and time-spans, biases in data extraction and study selection, publication bias, and papers' inaccessibility are the leading causes for missing relevant primary studies [41]. Search terms are kept aligned to the research questions and selected based on agile software development and project portfolio management concepts. The search string is kept generic enough to include as many studies as possible that refer to the key terms of "agile" and "portfolio." The snowballing process and the searches across the six databases have helped minimize the risk of missing out on relevant studies.

Issues in the interpretation of data could lead to potential threats to the study's *conclusion validity*. An "audit trail" of review records maintained on an Excel spreadsheet capturing detailed reasons for including or excluding a study mitigates against threats of bias during data extraction. Studies varied in the detail provided around their methods, their settings, analyses performed, and the conclusions drawn. These are reflected in the quality assessment carried out in Stage 3, leading to the elimination of 12 studies (from the 33 studies available for quality assessment) due to inadequate rigor and detail, thus minimizing the risk of inaccuracy during data extraction.

4 Findings

The literature review identified 21 empirical studies relating to portfolio management in environments using agile software development practices (Source studies are listed in the Appendix and are referred to in upcoming sections using their identifiers ranging from S01 to S21). **Fig. 2** shows summarized bibliometric information.

The distribution of publication dates (**Fig. 2** – graph 1) reveals that research into this area is sporadic and that much of the limited work in this area appears in the last five years[6]. The selected studies included nine journal articles (43%) and 12 conference papers (57%) (**Fig. 2** – graph 2).

Most studies (19 studies or 90%) were based on qualitative research designs (**Fig. 2** – graph 3). The case study method was by far the most common approach used to explore portfolio management in agile environments (17 studies or 80%), with the researcher(s) closely affiliated to the case organization(s).

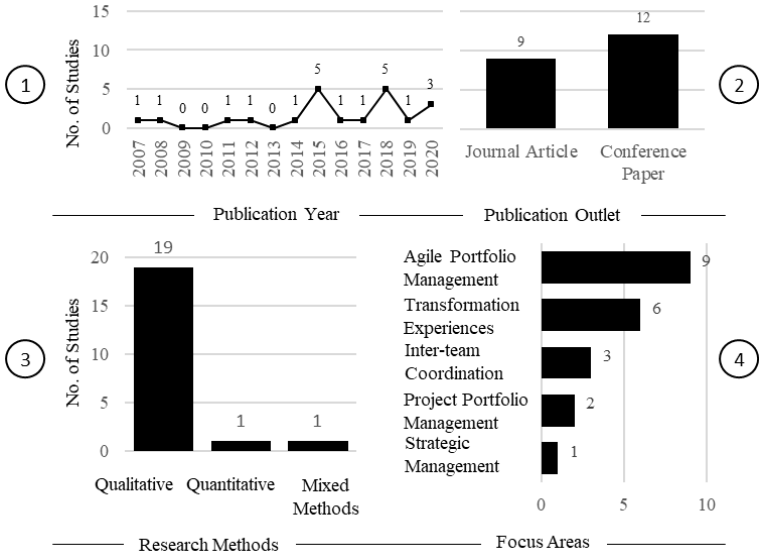


Fig. 2. Summarized bibliometric information

The reviewed studies' focus areas were classified into five groups to appreciate the diversity of topics under research (**Fig. 2** – graph 4). Nine studies (43%) investigated agile portfolio management practices; six studies (29%) described enterprise-level agile transformation efforts directly impacting portfolio management practices; three studies (14%) researched implications of inter-team coordination in agile environments; two

[6] Note that the search strategy had not used any date filters and the results include all available papers until early June 2020 when the search was conducted.

studies (9%) explore project portfolio practices to enhance agility (although not directly referring to agile methods) and one (5%) that delves into areas of strategic management in context of portfolio management.

The studies called out potential effects of existing organizational mechanisms for managing IT investments (19 studies – 90%), human resources (15 studies – 71%), third-party vendor management (14 studies – 67%) and cultural aspects like acceptance by development teams and senior management commitment (21 studies – 100%) as crucial factors to consider while modifying portfolio processes. These general observations are similar to findings from past literature reviews on large-scale agile practices [33,32,34,35]. However, this review goes further to highlight a consistent need for portfolio processes to mature further to enable agility at the enterprise level.

4.1 Impacts on Portfolio Practices

In response to the research question RQ1, the review process studied the reported impacts on portfolio management practices and conceptually aggregated them into six key themes. These themes represent IT portfolio management aspects impacted by agile delivery methods and can be perceived as challenges in practice. **Table 4** lists these impacted portfolio areas.

Table 4. Impacted Portfolio Areas

No.	Impacted Portfolio Areas	Source studies	Count
1	Portfolio strategic alignment	S01, S02, S03, S05, S06, S09, S10, S11, S13, S14, S16, S18, S19, S20, S21	15 (71%)
2	Continuous delivery	S03, S05, S07, S09, S13, S14, S17	7 (33%)
3	Adaptive nature	S01, S04, S07, S09, S12, S13, S20	7 (33%)
4	Learning through feedback	S03, S04, S07, S09, S14, S16, S17, S18,	8 (38%)
5	Financial processes	S01, S04, S06, S12, S13, S20	6 (29%)
6	Performance indicators	S09, S13, S15, S16, S18, S19, S20	7 (33%)

Portfolio strategic alignment. Agile teams are characterized by increased interactions within and across portfolio components and actors (like customers and stakeholders), which increases portfolio level complexities (S01, S05, S10, S18). Similarly, interdependencies and conflicts across multiple agile development teams are resolved through direct interactions across teams (S03, S21). Portfolio management practices need to evolve to keep these interactions aligned to the strategic business objectives (S18) and address project interdependencies (S11) within the portfolio.

While the emergent strategy can be supported through portfolio rebalancing or reconfiguration (S09, S11, S13, S14, S16, S19), some studies highlight applying a

continuous improvement mindset to portfolio processes to enhance their capabilities to explore, sense, and respond to emergent strategy (S10, S18, S20). Portfolio processes should adequately communicate business strategy to all constituent teams (S01, S06, S18) to make dependencies visible, to create shared mental models to facilitate coordination (S02), and for planning project resourcing (S01, S09).

Continuous delivery. Agile teams require ongoing portfolio prioritization and selection to maintain the constant cadence in delivering business outcomes through their backlogs for each cycle (S05, S09, S13, S17) and to better support inter-team coordination of dependencies (S14). This continuous portfolio process of "feeding the machine" (S03) maintains the overall project delivery schedule and release plans. Portfolio processes need streamlining and simplification to synchronize planning cycles across technical iterations and business (S16) to help agile teams obtain adequate backlog information just-in-time for upcoming delivery cycles (S07, S09, S13) and to avoid build-up of work items that could rapidly become obsolete over time (S05).

Adaptive nature. The review observes a need for a leaner business case process (S01, S04, S07, S09, S12, S13, S20) to accommodate the adaptive and self-organizing nature of agile projects. Agile business cases provide "just enough" content needed to consider an IT investment option with details getting incorporated as requirements emerge with higher confidence (S12, S20) impact traditional portfolio governance and control processes relying on detailed business case assessment using project characteristics like scope, timelines, costs, benefits, and risks defined *a priori* [42]. Portfolio processes need to bridge gaps between existing organizational processes aligned with traditional stage-gate approaches and agile development processes (S04).

Learning through feedback. The classical portfolio management approach of measuring project outcomes against pre-defined success (or failure) criteria based on upfront plans is contrary to the agile way and can inhibit the organization from learning from its project experiences (S04, S18). Concepts like lean-startup and learning through experimentation (S17) in agile teams require portfolios to use continuous feedback mechanisms across the development lifecycle (S09) on projects constructed as proof-of-concept hypotheses (S04). Portfolio processes should extend the feedback-based learning mechanism from agile teams to adjacent business and management domains (S14) and sustain organizational learning (S03).

Traditional portfolio approaches assume resources to be fungible and continually (re)allocates them based on business priorities resulting in frequent context switching that can create unrest (S14) and limit learning ability (S16).

Financial processes. Portfolio mechanisms need to bridge the gap between shorter and adaptive planning cycles required for agile development with the longer horizons and stable plans mandated by the business (S04, S06, S12, S13). Traditional project valuation methods (using measures like Net Present Value and Earned Value Analysis) do not adequately support the use of agile value metrics (like Net Promoter Score, product demo feedbacks, or metrics like cycle-time and throughput). (S01, S04) The evolving business case process also reflects this need to raise funding to a level higher than an individual project (S20).

Performance indicators. Portfolio metrics need to reflect enterprise performance at the highest level to reflect the business impact of projects implemented (S09), and not just be considered output control mechanisms (S13). Many of the traditional metrics, like the Schedule Performance Index (SPI) and the Cost Performance Index (CPI), have no relevance in an agile environment, requiring portfolio management to identify more insightful metrics (S20). The sole study focusing on reporting in agile portfolios describes it as an "information exchange mechanisms across boundaries of knowledge domains" (S15). The portfolio could institute appropriate structures and routines (like a PMO) to coordinate this knowledge exchange (S16, S19) and periodically assess how well the IT portfolio and its constituent projects adapt to environmental changes (S18).

4.2 Agility approaches in practice

The review identified various portfolio practices that enterprises adopt to address (or at least minimize) impacts from agile development methods to address the research question RQ2. The respective organizational context plays a role in adopting these practices. Since most studies in the review had an exploratory or descriptive focus, they do not provide any causal insights into how a specific practice contributes to portfolio agility. **Table 5** shows these practices mapped to their respective portfolio areas of impact.

Table 5. Portfolio level approaches adopted to support agile methods

No.	Portfolio Area	Approach adopted	Source Studies	Count
1	Portfolio Strategic Alignment	Portfolio backlogs provide end-to-end visibility	S01, S02, S04, S06, S07, S09, S10, S11, S13, S14, S16, S19, S20, S21	14 (67%)
		PMO structures to facilitate visibility	S14, S19, S20	3 (14%)
2	Continuous Delivery	Shorter portfolio cycles	S06, S10, S20	3 (14%)
		Collaborative planning	S11, S17	2 (10%)
		JIT approvals	S01, S03, S05, S09	4 (19%)
		Continuous Prioritization	S04, S09, S13	3 (14%)
3	Adaptive nature	Customer value as the basis for evaluation	S01, S06, S09, S13	4 (19%)
		Shorter planning cycles	S10, S20	2 (10%)
		Planning at higher levels of abstraction	S04, S09, S14, S20	4 (19%)
4	Learning through feedback	None	None	
5	Financial Processes	Continuous forecasts	S09, S12, S13, S20	4 (19%)
6	Performance indicators	PMO structures to facilitate reporting	S13, S15, S19	3 (14%)

Portfolio strategic alignment. Portfolio backlogs showing strategic investment themes and how they relate to portfolio components like epics, features, and stories (S09, S11), often implemented as Kanban (S01) or portfolio walls (S09), provide end-to-end portfolio visibility to enterprise stakeholders. They allow portfolios to continuously adapt to upstream changes in business strategy or product line directions and ensure appropriate downstream adaptations within teams (S05). End-to-end portfolio visibility also aids in streamlining coordination across teams (S06, S11, S16, S21), strengthens the communication process, facilitates joint decision-making, builds trust, and enhances collaboration within the team and across stakeholders (S04, S13, S14). The PMO is an enabling structure to manage this visibility (S14, S19, S20).

Continuous delivery. Agile portfolios advocate short portfolio cycles (S10, S20) synchronized at multiple integration points (S06) with project approvals and epic/solution details provided just-in-time for immediately upcoming cycles (S01, S03, S05, S09) to ensure adequate utilization of the development pipeline and to avoid requirements or projected benefits becoming stale while in the development pipeline. Collaborative and visual planning led to better continuous planning outcomes (S11, S17). Continuous prioritization of the portfolio (S04, S09) based on ongoing feedback keeps development teams aligned to portfolio objectives (S13).

Adaptive nature. Business case evaluation and prioritization utilize portfolio parameters based on customer value (S01, S06, S09, S13), although portfolio practitioners have found it difficult to evolve acceptable, consistent, and measurable definitions of "*value*" (S11). Traditional portfolio practices can support the adaptive nature of agile methods by having shorter portfolio cycles (S06, S10, S20) and by defining projects as features or value propositions (S04) at higher levels of abstraction (S20).

Learning through feedback. While agile methods applied at the team level facilitates learning through feedback cycles, none of the studies reported any conscious portfolio practice to facilitate portfolio level learning. One study recommended knowledge replication as a potential practice (S07) but did not offer any further detail.

Financial processes. Agile organizations are moving from budget controls to more of an emergent outcome control model (S13). Rolling wave forecasts, where a continuous cadence of forecasts replaces the traditional fixed horizon budget process, is a significant shift in the way enterprises manage project funding (S09, S12, S20). Another meaningful change is the shift towards funding product/feature teams instead of projects (S12) and moving cost center planning to a more aggregated level (S11).

Performance indicators. One study identifies a set of reporting practices used in portfolios to share information across knowledge domain boundaries (S15) effectively. PMOs have a role in consolidating and disseminating metrics across the portfolio, especially end-to-end metrics like "Time to Market Improvement" and "Customer Satisfaction" (S13, S15, S19).

5 Discussion

This literature review identifies six portfolio management aspects impacted by incorporating agile efforts in the portfolio (Section 4.1) to answer the first research question (RQ1). The various antecedents linked to the challenges identified provide the background to frame further research studies into these areas. In response to the second research question (RQ2), the review recognizes practices/approaches adopted by enterprises to achieve agility in their IT portfolios (Section 4.2). These practices/approaches are mapped to the six aspects impacted by agile projects (RQ1) to reflect potential resolutions to the challenges identified. This review does not attempt to evaluate their relative merits due to the varying level of exploratory detail across studies. Further empirical evaluation of these practices and their contribution to portfolio success and agility through each of the six portfolio management aspects is recommended.

Many studies in this review (S01, S05, S06, S11, S13, S14, S18) have observed that the field of agile portfolio management is relatively unexplored. This literature survey shares the same view based on the low number of empirical studies (21 studies) identified. An analysis of overall scores[7] from the quality assessment conducted in Stage 3 leads to an inference around the relatively low strength of evidence across many studies, possibly requiring further research to validate their theoretical contribution claims.

5.1 Implications of findings

Practitioners involved in scaling agile practices across an enterprise should view the six portfolio management aspects impacted by agile delivery efforts as crucial factors in enabling portfolio level agility. Enterprises should reflect on the identified practices/approaches using their respective organizational context since the reviewed literature does not identify any specific causal relationship.

There are three implications to research and practice from the findings in this review.

1. ***Shifting from reactive to proactive approaches.*** Portfolio management literature [10,43,44] acknowledges that maintaining strategic alignment is one of portfolio management's key objectives, achieved through top-down approaches aligning enterprise objectives to IT priorities [11]. This traditional approach towards portfolio management appears reactive as it focuses on reconfiguring its components as a response to business strategy changes. Studies in this review describe portfolio backlogs and Kanban as tools to provide visibility into portfolio components, their alignment to strategic themes, and their priorities (S01, S09, S11), allowing for an effective response to changes, once sensed. It is unclear how these tools help portfolios become proactive in sensing changes to their dynamic environments to enable enterprise agility.

[7] Some descriptive statistics of the overall quality assessment scores are as follows: n = 21, mean = 3.50, median = 3.20, min = 2.6, max = 4.8

One of the reviewed studies (S11) indicates that it could take months before a new project is accepted into a supposedly agile portfolio – inhibiting the ability to enable continuous delivery. Two studies (S06, S18) offer recommendations around continuous portfolio exploration, and further investigation is needed to explain how portfolios could shift to more proactive approaches to support continuous delivery expectations.

2. ***Adopting a systems-thinking approach***. Sweetman et al. (S18) present a unique view of an agile portfolio as a complex adaptive system. Cao et al. [45] had proposed the study of agile software development projects as a dynamic, integrated system, given its use of autonomous teams, frequent iterations incorporating feedback, and continuous adaptation of product features. Therefore, a portfolio system, characterized by its routines, structures, and values (S14), essentially becomes a "system of systems" consisting of various individual agile efforts.

   A systems-thinking approach could explore a portfolio system as a set of interactions across multiple interconnected and interdependent components to collectively achieve the portfolio objectives.

3. ***Changes to existing organizational processes***. Studies indicate that existing strategic planning and investment management processes impact agile portfolio implementations (S09, S12, S13, S20). Cao et al. [46] suggest that agile efforts require modified enterprise project budgeting structures and processes due to limitations of traditional project appraisal, expense capitalization, and contract valuation methods [47]. Beyond Budgeting [48], Multi-Level Budgeting [49], and Real Options [50] are alternate options to be further explored. Krebs [24] recommends the use of dynamic financial models to drive portfolio agility, while the Scaled Agile Framework (SAFe) advocates the practice of lean portfolio management [25], applying principles from lean systems [51] to align strategy and execution. Dikert et al. [34] recognize the crucial role of non-IT functions in successfully scaling agile practices across the enterprise and recommends further research into this area.

5.2 Limitations of this study

The explicitly defined review protocol detailing the various stages of the process mitigates most limitations related to potential biases in study selection and data extraction. The more experienced researchers independently validated this review protocol to reduce bias in the process. Although a sole researcher conducted the multi-stage study selection process due to resource constraints, the "audit trail" of inclusion/exclusion decisions helped traceability while reviewing the work.

Despite a widened search process to accommodate as many studies as possible across the field of inquiry, only a few empirical studies (21 studies) were identified, meeting all the pre-defined selection criteria. Coupled with the relatively low scores observed in the quality assessment process, this indicates a need for further empirical research in this area.

6 Conclusions and future research directions

The six aspects of portfolio management identified in this review as impacted by agile delivery (in response to RQ1) and the various solution approaches described (in response to RQ2) present opportunities for future exploration to identify causal explanations, configurational patterns, and the nature/extent of their relationships to agility and portfolio success. While some of the reviewed studies illustrated how portfolios are reconfigured to 'respond' to changes, there was no depiction of how portfolios 'sense' changes or 'learn' from these changes to optimize future responses. Future studies are needed to understand the "sensing' and 'learning' aspects of portfolio agility.

Using a systems-thinking lens to model and diagnose agile portfolio structures, processes, and interactions is another potential research avenue, leading to the definition and analysis of possible portfolio methods enabling agility at different levels of the organization. Another research direction for the future could be around the systemic interfaces and dependencies of adjacent organizational processes (like HR and Finance) on portfolio practices and their impacts on agility.

This literature review makes three contributions to academic knowledge. Firstly, it synthesizes current knowledge of how project portfolios enable IT agility while incorporating agile delivery efforts. Secondly, it responds to the specific questions by identifying six portfolio management aspects impacted by agile delivery practices and a set of current practices used within enterprises to contribute to portfolio agility. Finally, the implications of these findings have helped identify possible future research directions, some of which are explored by the authors in the upcoming stages of designing an agile portfolio management framework.

Appendix – Selected Studies

ID	Citation
S01	Ahmad, M.O., Lwakatare, L.E., Kuvaja, P., Oivo, M., Markkula, J.: An empirical study of portfolio management and Kanban in agile and lean software companies. Journal Of Software: Evolution and Process 29(6), 1-16 (2017).
S02	Bjørnson, F.O., Wijnmaalen, J., Stettina, C.J., Dingsøyr, T.: Inter-team coordination in large-scale agile development: A case study of three enabling mechanisms. In: International Conference on Agile Software Development 2018, pp. 216-231. Springer (2018)
S03	Dingsøyr, T., Moe, N.B., Fægri, T.E., Seim, E.A.: Exploring software development at the very large-scale: a revelatory case study and research agenda for agile method adaptation. Empirical Software Engineering 23(1), 490-520 (2018).
S04	Hansen, L.K., Brandt, C.J., Svejvig, P., Kampf, C.E.: Agile project portfolio management, new solutions and new challenges: findings from four agile organizations. In: EURAM Conference (2020)
S05	Hoffmann, D., Ahlemann, F., Reining, S.: Reconciling alignment, efficiency, and agility in IT project portfolio management: Recommendations based on a revelatory case study. International Journal of Project Management 38(2), 124-136 (2020).

ID	Citation
S06	Horlach, B., Schirmer, I., Drews, P.: Agile portfolio management: Design goals and principles. In: 27th European Conference on Information Systems (ECIS), Stockholm-Uppsala, Sweden 2019. AIS Electronic Library (AISeL) (2019)
S07	Imbrizi, F.G., Maccari, E.A.: Agile Software Development and Project Portfolio Management in Dynamic Environments: An exploratory case study. In: International Association for Management of Technology (2014)
S08	Kaufmann, C., Kock, A., Gemünden, H.G.: Emerging strategy recognition in agile portfolios. International Journal of Project Management (2020).
S09	Laanti, M., Sirkiä, R., Kangas, M.: Agile Portfolio Management at Finnish Broadcasting Company Yle. In: Scientific Workshop Proceedings of the XP2015, pp. 1-7. ACM (2015)
S10	Petit, Y.: Project portfolios in dynamic environments: Organizing for uncertainty. International Journal of Project Management 30(5), 539-553 (2012).
S11	Rautiainen, K., Von Schantz, J., Vähäniitty, J.: Supporting scaling agile with portfolio management: Case Paf.com. In: 44th Hawaii International Conference on System Sciences 2011, pp. 1-10. IEEE (2011)
S12	Sirkiä, R., Laanti, M.: Adaptive Finance and Control: Combining Lean, Agile, and Beyond Budgeting for Financial and Organizational Flexibility. In: 48th Hawaii International Conference on System Sciences 2015, pp. 5030-5037 (2015)
S13	Smeekes, I., Borgman, H., Heier, H.: A Wheelbarrow Full of Frogs: Understanding Portfolio Management for Agile Projects. In: 51st Hawaii International Conference on System Sciences 2018, pp. 5473-5482. IEEE (2018)
S14	Stettina, C.J., Horz, J.: Agile portfolio management: An empirical perspective on the practice in use. International Journal of Project Management 33(1), 140-152 (2015).
S15	Stettina, C.J., Schoemaker, L.: Reporting in agile portfolio management: Routines, metrics and artefacts to maintain an effective oversight. In: International Conference on Agile Software Development 2018, pp. 199-215 (2018)
S16	Stettina, C.J., Smit, M.N.W.: Team portfolio scrum: An action research on multitasking in multi-project scrum teams. In: International Conference on Agile Software Development 2016, pp. 79-91 (2016)
S17	Suomalainen, T., Kuusela, R., Tihinen, M.: Continuous planning: an important aspect of agile and lean development International Journal of Agile Systems and Management 8(2), 132-162 (2015).
S18	Sweetman, R., Conboy, K.: Portfolios of Agile Projects A Complex Adaptive Systems' Agent Perspective. Project Management Journal 49(6), 18-38 (2018).
S19	Tengshe, A., Noble, S.: Establishing the Agile PMO: Managing variability across Projects and Portfolios. In: Proceedings of Agile 2007, pp. 188-193. IEEE (2007)
S20	Thomas, J.C., Baker, S.W.: Establishing an agile portfolio to align IT investments with business needs. In: Proceedings of Agile 2008, pp. 252-258. IEEE (2008)
S21	Vlietland, J., van Vliet, H.: Towards a governance framework for chains of Scrum teams. Information and Software Technology 57, 52-65 (2015).

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