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Review

Approaches for Hybrid Scaling of Agile in the IT Industry: A Systematic Literature Review and Research Agenda

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Abstract: Agile methodologies, initially designed for the project level, face challenges when applied at enterprise levels where complex projects and diverse stakeholders are involved. To meet this challenge, several large-scale agile methodologies have been proposed. However, these approaches are not flexible enough or tailored to the needs of organizations, projects, and their teams. It is in this context that hybrid methodologies have emerged. This study aims to conduct a systematic literature review to trace the evolution of hybrid scaling of agile and characterize different approaches to implement it. This study starts by assessing 1509 studies through the use of the PRISMA 2020 framework and identifies 38 relevant studies in this field. The findings indicate that the majority of studies are from 2021 onwards and that qualitative methodologies supported by case studies predominate, making it possible to characterize tailoring processes in these organizations. Moreover, the implementation of hybrid scaling of agile is supported by the paradigm of ambidextrous strategy, a combination of agile with traditional project management methodologies, and continuous improvements. This study contributes insights into navigating the complexities of agile scaling, offering practical guidance for organizations seeking to optimize their project management practices.

Keywords: large-scale agile; hybrid approaches; project management; software engineering; software methodologies; systematic literature review

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1. Introduction

Agile refers to a specific methodology or set of principles, often within the context of software development or project management. The work in an agile environment is divided into small, iterative cycles called "sprints", typically lasting 1–4 weeks [1]. Each sprint involves planning, executing, testing, and reviewing a set of features or tasks. Teams collaborate closely with stakeholders, regularly reassessing and adjusting priorities based on feedback and changing requirements. Accordingly, agile promotes continuous improvement, with a focus on delivering functional, incremental updates rather than a single, final product, allowing teams to respond quickly to changes and deliver value more frequently [2]. Agile methodology, due to its inherent adaptability, efficiency, and user-centric approach, is vital for those companies or industries that face rapid evolution, have a need for fast implementation of change, and aim to maximize the creativity of the employees, for example, for the future evolution of the internet [3,4]. As the internet continues to evolve rapidly, the ability to respond swiftly to changes, innovations, and emerging technologies becomes crucial. Agile can be interpreted both on the organizational level [5,6] and on the project level [7–9]. Both aspects have the same aim, i.e., wanting to maximize the capability of reacting to changing customer needs. However, the scale is—by nature—different. An agile organization mainly focuses on maximizing the efficiency of the primary operational products or services of the company, while agile project management focuses on the most efficient delivery of the project, i.e., maximizing the client's satisfaction [5]. This latter is

encapsulated in a more dynamic implementation process where—in cooperation with the client—continuous reprioritization takes place [10,11]. In accordance with the aim of the paper, the authors focus on the second aspect. The need for the aforementioned flexibility in project management emerged in the early 70s, but the elaboration of advanced approaches and widespread methodologies was the achievement of the new millennium [11,12]. The Project Management Institute (from now on: PMI) [8] identified four project management approaches: one planning-oriented (predictive) and three dynamics (incremental, iterative, and the combination of these two, adaptive). PMI [8] also highlights that agile belongs to the latter, the adaptive category, and it identifies 12 methodologies and categorizes them based on the breadth of the life cycle coverage and the depth of the guidance detail. Other authors also find similar or other methods and approaches [13,14]. Researchers also highlight Scrum as the most popular agile project management that mainly focuses on managing smaller teams; however, it was adapted to larger projects as well by aligning the different teams together [15,16]. This also resulted in the need for extra coordination and empowerment at the same time both on project and scrum level, and as a result of this, the classic project management was spread between several roles. Product owners (and in some organizations, project owners) are mainly responsible for the project result, and the scrum masters for the implementation process.

Agile's iterative and incremental development process allows for continuous feedback and improvements, and triggers creativity more effectively than other project management approaches, ensuring that internet technologies can keep pace with dynamic user needs and market demands [17]. Predictive approaches, by contrast, often delay value realization until the end of the project, which can be risky if market conditions change or if the project faces delays. In the context of the internet, where trends and technologies shift rapidly, agile methodologies facilitate quick pivots and adjustments. As pointed out by Nozari and Ghahremani-Nahr [18], this responsiveness is essential for integrating new advancements such as artificial intelligence, blockchain, and the Internet of Things (IoT) into the web infrastructure. Agile practices enable development teams to experiment with these technologies, gather user feedback, and refine solutions in short cycles, promoting innovation and reducing the risk of project failures [19–21]. Moreover, the user-centric nature of agile aligns perfectly with the future internet's focus on personalized experiences. Weichbroth [22] reports that agile methodologies prioritize user feedback and involvement throughout the development process, ensuring that evolving internet services are tailored to meet diverse user preferences and behaviors. This contrasts with predictive approaches, where the separation between planning and execution phases can lead to a disconnect between initial plans and the final deliverable. Agile also supports the collaborative efforts necessary for the internet's evolution. The framework encourages cross-functional teams and stakeholder collaboration, fostering a culture of shared responsibility and collective problem-solving. This collaborative environment is crucial for tackling complex challenges such as cybersecurity threats, data privacy concerns, and ensuring global internet accessibility [23,24].

PMI highlights the need for tailoring not only on the project level, but also in the case of methodologies [8,25]. Based on the literature, this can be twofold. On the one hand, authors highlight the need for hybrid approaches, which combine agile and predictive (waterfall) approaches, due to harnessing the advantage of planning and adaptation at the same time, and apply a hybrid project management approach [8,11,26]. Other authors identified the need for exceeding the project level and argue for shaping organizational structures or the project management practices in use in a way to support applying agile in large-scale projects [27–29]. Accordingly, large-scale agile refers to the application of agile principles and practices across multiple teams working on a complex, often enterprise-level project. It involves coordinating and aligning multiple agile teams to ensure consistent delivery, collaboration, and integration. Scaling agile is crucial for organizations aiming to maintain competitive advantages in complex and rapidly changing markets. As businesses grow, their operations, projects, and product lines often expand in complexity and scope.

Agile methodologies, initially designed for small, co-located teams, must be scaled to ensure that the benefits of flexibility, speed, and responsiveness are realized across the entire organization. One key reason for scaling agile is to maintain alignment and coherence in large, distributed teams. When agile practices are scaled, they provide a structured framework that facilitates coordination across multiple teams working on interconnected projects. This ensures that all teams are aligned with the organization's strategic goals and can respond uniformly to changes in market conditions or customer needs. Without scaling agile, different teams might develop in silos, leading to misalignment, inefficiencies, and a fragmented product or service offering [30,31]. Furthermore, scaling agile enhances the ability to manage dependencies and integration points between different teams and projects [32]. In large organizations, projects often rely on each other's outputs, and a delay in one area can cascade into significant setbacks. Additionally, Verwijs and Russo [33] report that scaling agile fosters a culture of continuous improvement and learning at an enterprise level. By implementing large-scale agile practices across the organization, companies aim to create feedback loops that span multiple teams and departments, leading to systemic improvements in processes, quality, and innovation.

Implementing large-scale agile requires a strategic approach that encompasses organizational culture, structure, processes, and tools. One effective approach to scaling agile is adopting a proven framework such as SAFe (Scaled Agile Framework), LeSS (Large Scale Scrum), Nexus, Disciplined Agile (DA), or Spotify Model. These frameworks provide structured methodologies for scaling agile across multiple teams and departments. For instance, SAFe offers guidance on aligning strategy with execution, managing multiple agile teams, and ensuring continuous delivery of value [34]. LeSS focuses on simplifying organizational structure and optimizing communication channels to enhance collaboration [34]. These approaches have gained prominence in the IT industry. According to the 2023 "State of Agile" report by Digital.ai [35], which is one of the most comprehensive and widely cited benchmarks for agile adoption, over 90% of organizations reported practicing agile in some form. This report also highlighted that 59% of respondents have implemented agile practices at a scale that involves multiple teams working in concert across the organization, reflecting the widespread move towards large-scale agile frameworks. Among the most popular frameworks for scaling Agile, SAFe continues to lead, with about 53% of organizations using it as their primary approach to scaling agile. Other prominent methodologies include LeSS, Disciplined Agile Delivery (DAD), and Nexus, each varying in their adoption depending on the specific needs and structure of the organization.

Systematic literature reviews (SLRs) in large-scale agile essentially aim to compare different implementation frameworks and the challenges related to the scaling process [36–39]. Moreover, it is now evident that a well-based and proper application of the agile project management methodology can increase the potential for project success [40], and there are numerous papers focusing on the definition and proper use of agile on the project level; however, the organizational level—especially considering those papers which use SLR as a methodology—is neglected [37,41]. However, as Kasauli et al. [42] report, organizations find it difficult to adopt these frameworks as they are highly complex and do not capture the organizational and cultural particularities of each company. As a response to this challenge, there have been reports of hybrid frameworks being adopted which are the result of adaptations made by companies to better reflect and capture the needs of their teams and projects [43,44]. Despite this, and to the best of our knowledge, there are no SLRs that allow us to understand how these hybrid frameworks are structured and what their role is in improving project management on a large scale in the context of IT organizations. Accordingly, this study aims to systematically review the existing literature on hybrid scaling approaches within agile frameworks. By synthesizing current research, this study seeks to clarify how different hybrid models integrate agile practices with traditional project management techniques to address the unique demands of large-scale IT projects. The goal is to provide a comprehensive overview of effective strategies, highlight critical gaps in the literature, and propose a research agenda for advancing hybrid scaling methodologies.

Furthermore, research questions that guide the analysis and interpretation of the results are provided in Section 2.5. This SLR follows a structured, transparent process to identify, select, and analyze relevant studies, aiming for objectivity and replicability. The main difference regarding a narrative literature review lies in the systematic review's rigorous approach compared to the narrative review's more flexible, interpretive style. It is important to note that the authors understand large-scale hybrid approaches as a combination of agile methodologies to manage complex and enterprise-level projects (like Scrumban), i.e., as an inter-agile phenomenon, and as a combination of predictive and agile, i.e., as an intra-agile phenomenon c.f. [8]. It synthesizes key insights and trends, providing a comprehensive understanding of how organizations integrate agile methodologies at scale. Additionally, this study proposes a research agenda to address gaps and guide future investigations, aiming to enhance theoretical and practical knowledge in scaling agile frameworks within IT industries.

The rest of this paper is organized as follows: Initially, the methodological process is presented in which the various phases of the SLR are presented, the sources of information used, the inclusion and exclusion criteria, and the research questions. The results are then organized according to the previously defined research questions. This is followed by a discussion of the relevance of the results and a section presenting a research agenda in the field. Finally, the article concludes with a summary of the study's main conclusions and its main limitations.

2. Research Methodology

2.1. Methods

SLRs can be characterized as a rigorous and methodical approach to reviewing and synthesizing research evidence on a particular topic. Unlike traditional literature reviews, SLRs follow a well-defined protocol that includes a clear formulation of research questions, comprehensive and reproducible search strategies, predefined inclusion and exclusion criteria, and critical appraisal of the included studies. According to Kolaski et al. [45], Mengist et al. [46], and Xiao and Watson [47], this systematic approach aims to minimize bias and provide a transparent, replicable, and exhaustive summary of the existing research evidence.

The importance of SLRs lies in their ability to offer a comprehensive and unbiased synthesis of the research landscape. An important benefit of an SLR is presented by Snyder [48], who highlights its role in identifying gaps in the literature and emphasizing areas where further research is needed. Furthermore, SLRs can also reveal inconsistencies and variations in study results, leading to a better understanding of the factors that influence outcomes.

In the context of the software industry, project management is a critical discipline that ensures the successful delivery of software products and services. An SLR in this context serves as a powerful tool to consolidate and synthesize the vast and rapidly evolving body of knowledge related to software project management. The use of a rigorous and methodical approach can provide numerous benefits that are essential for advancing the practice and effectiveness of project management in this dynamic field. These benefits are highlighted in SLRs performed in the software project management field. Kitchenham et al. [49] point out the potential for developing standardized frameworks and guidelines that can be widely adopted across the industry. Cerdeiral and Santos [50] add that this approach promotes consistency, reliability, and continuous improvement in managing software projects. Another significant contribution of SLRs is their role in identifying research gaps and emerging trends within the field. As the software industry continually evolves with new technologies, methodologies, and market demands, it is imperative to stay abreast of the latest developments. The work performed by Nenni et al. [51] highlights areas where further research is needed, fostering innovation and encouraging the exploration of novel approaches that can address current and future challenges in software project management.

This study also adopts bibliometric software for data analysis. The primary importance of these tools lies in their ability to analyze and visualize vast amounts of bibliographic

data, which is crucial for systematically assessing the state of knowledge within a particular field. VosViewer (version 1.6.20) was used to visualize complex bibliometric networks. It enables us to map co-authorship, co-citation, and keyword co-occurrence, offering a visual representation of the relationships between different studies, authors, and concepts. This visualization is important for uncovering the underlying structure of the research landscape, revealing clusters of related research and emerging areas of interest. The efficiency and scalability of bibliometric software are particularly beneficial given the increasing volume of academic publications that also occur in the field of software project management. It is noted that traditional manual methods of literature review are often time-consuming and prone to human error.

2.2. Phases and Quality Assessment

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was adopted in this study. Therefore, this study complies with the PRISMA 2020 guidelines. PRISMA offers a set of guidelines designed to improve the reporting of systematic reviews and meta-analyses. It provides a framework that helps researchers transparently report why the review was conducted, what they performed, and what they found. The guidelines include a 27-item checklist and a four-phase flow diagram to ensure comprehensive reporting. These guidelines help researchers ensure that all critical aspects of the review process are disclosed, including the rationale for the review, the methods used to identify and select studies, and the techniques employed to assess their quality and extract data [52,53]. Furthermore, this level of detail allows readers to understand the robustness of the review process and assess the reliability of the findings. All these guidelines and phases were followed, and the process of identifying and removing studies along the four phases is presented in Figure 1. Initially, 1509 studies were identified from both databases. 271 records were removed before screening due to duplication issues. These duplicated records were identified based on Digital Object Identifier (DOI). A large number of abstracts were accessed (n = 1238). However, most of them concern studies of the application of agile on a small scale and in the specific context of projects with small teams. After this phase, only 293 articles were downloaded to perform a full-text reading. However, 38 articles were not retrieved due to server downtime after three attempts. Therefore, 255 studies were accessed for eligibility. In the final phase, 217 articles were eliminated, mainly because they dealt with the implementation of agile using agile large-scale frameworks such as SAFe, LeSS, and others. These frameworks provide a structured approach to scaling agile across large organizations. Hybrid approaches, on the other hand, blend agile with other methodologies or practices, depending on the needs of a particular project or organization. At the end of the process, 38 studies that effectively explore the adoption of hybrid approaches in large-scale software development teams were included in this systematic review. The list of all documents included in this SLR is provided in Appendix A.

2.3. Inclusion and Exclusion Criteria

This SLR includes articles published in the last decade between 2015 and 2024. As the SLR was carried out at the beginning of the 2nd semester of 2024, only articles published up to June of that year were considered. Only peer-reviewed articles published in indexed journals were included. Articles written in English and whose full text is accessible were considered.

The exclusion criteria were articles whose abstract was written in English but whose full text was only available in the authors' original language. Registers were not considered to not include preprint versions of articles. During the process of accessing the full text of the articles, problems were encountered in accessing some articles published in indexed scientific journals but whose access to the server was rejected. A new download attempt was made a week after this error, and the articles whose access was unavailable were rejected. All articles published in the proceedings of national and international conferences

were also excluded. Similarly, books and book chapters were not included. Dissertations and theses were also not included in this SLR.

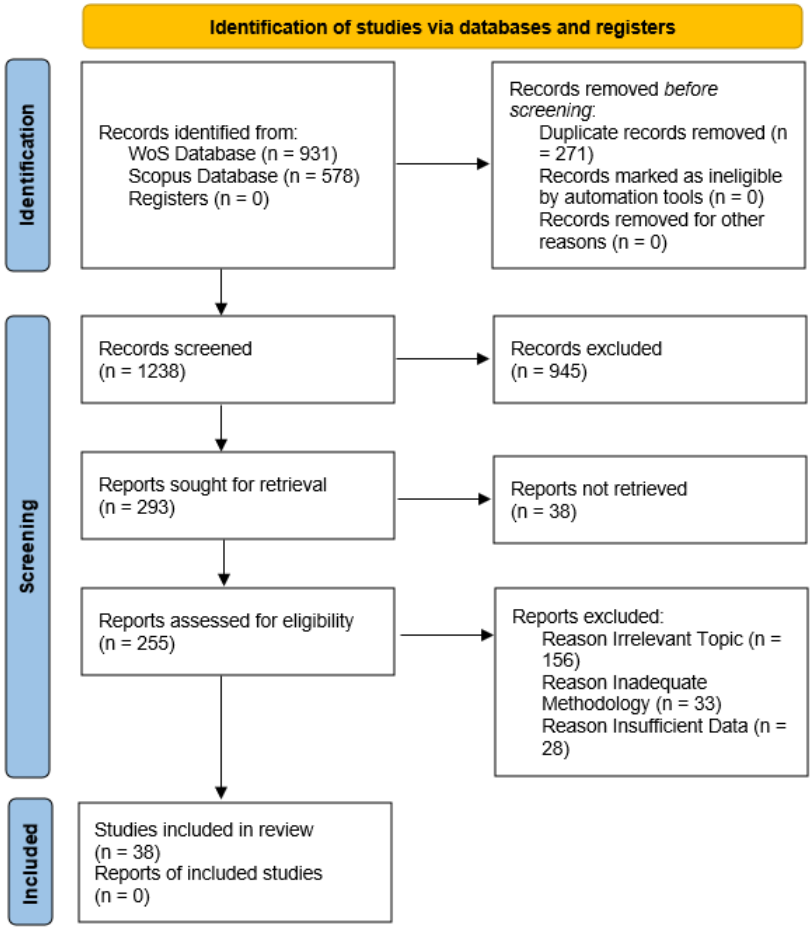

Figure 1. Phases of the SLR process.

2.4. Databases and Search Strategy

This study uses two scientific databases: Web of Science (WoS) and Scopus. The use of both databases offers several compelling advantages that enhance the quality, comprehensiveness, and reliability of the review process. These databases are among the most widely recognized and utilized for academic research, providing a solid foundation for conducting thorough and credible literature reviews [54,55]. Furthermore, both databases offer sophisticated search functionalities and advanced filtering options, which are essential for conducting a systematic and reproducible literature search. This feature allows us to construct precise search queries, apply relevant filters, and refine their results to include only the most pertinent studies. Another important reason to utilize WoS and Scopus is their emphasis on citation analysis [56]. Both databases provide detailed citation data, enabling us to track the impact and influence of specific studies within the software community.

A preliminary exploratory research based on studies that address scaling issues of agile was performed to identify relevant search keywords. We have recognized that most studies that adopt hybrid large-scale frameworks do not report it in the keywords associated with each article. Therefore, we have followed a more general strategy that uses more recognized keywords such as "large scale agile", "scaling agile", and "scaled agile". This approach makes it possible to capture a large number of articles as shown in the PRISMA diagram, which is why the process of excluding studies was more time-consuming and exhaustive. These three keywords were combined according to the algebraic expression: "large scale agile" OR "scaling agile" OR "scaled agile". These search terms were applied to the title, abstract, and keywords. Both authors worked independently during this search process

with a consensus meeting at the end of the process to identify divergent classifications. No automation tools were used in this process. Information regarding the authors, title of each article, year of publication, research methodology, and funding support was collected.

2.5. Research Questions

SLRs are structured approaches to synthesizing existing research on a specific topic, and they commonly address several core research questions. One frequent generic question is "What is the current state of knowledge on the topic?" This is crucial as it provides a comprehensive understanding of what is already known, identifying gaps in the literature and guiding future research efforts. Furthermore, this helps in understanding the predominant approaches and their effectiveness, ensuring that future studies can build on robust foundations or explore alternative methodologies where current ones may be lacking. Therefore, and to characterize this phenomenon, this study has established the following research questions:

RQ1. What is the distribution of studies over the last decade?
RQ2. Which journals have published these studies?
RQ3. What level of association can be established between these journals?
RQ4. Which research methodologies predominate?

Additionally, exploring the connection between key terms in an SLR is important for several reasons. Firstly, it helps in uncovering the relationships and interdependencies between various concepts within the research domain. Understanding these connections allows researchers to see how different aspects of a topic interact and influence each other, leading to a more comprehensive and nuanced understanding of the subject. Secondly, identifying the connections between key terms aids in mapping the landscape of the existing research. This mapping can highlight clusters of studies that focus on similar themes and identify areas that have been extensively studied versus those that remain underexplored. It can also expose inconsistencies or gaps in the literature, guiding future research efforts to address these gaps or reconcile conflicting findings. Moreover, exploring these connections enhances the rigor and relevance of the SLR [57]. It ensures that the review is not merely a collection of isolated studies but a coherent synthesis that integrates findings across different studies. Accordingly, two more research questions were established:

RQ5. What network of connections is established between the key terms of the studies?
RQ6. Which clusters are identified among these key terms?

Finally, this SLR adopted a thematic synthesis, which is a method of qualitative synthesis that involves identifying, analyzing, and summarizing themes across studies. It provides a structured approach to integrating qualitative findings by coding and categorizing data to identify overarching themes or patterns. Thematic synthesis helps in understanding commonalities and differences among studies, allowing for a coherent summary of qualitative evidence. It often results in the development of new theoretical frameworks or conceptual models based on the synthesis of themes. Therefore, to explore the several approaches followed by the implementation of hybrid scaling of agile, this study has used cognitive maps. Cognitive maps are an essential tool for representing spatial information and environments, offering profound insights into how humans perceive, navigate, and interact with the world around them [58]. Furthermore, concept maps are graphical tools that illustrate relationships between concepts. This study has adopted CmapTools, developed by the Institute for Human and Machine Cognition (IHMC) to represent the different scaling strategies. Nodes are used to represent concepts and links are employed to represent the relationships between those concepts. Therefore, a final research question was included in this SLR.

RQ7. Which are the different hybrid approaches identified in published studies to scale agile?

RQ7 is particularly relevant considering the criticism that large-scale agile frameworks have received and, therefore, it is important to explore how hybrid large-scale approaches can mitigate these criticisms. Main issues are related to complexity and overhead, risk of

misalignment, and rigidness [27,59,60]. These frameworks can introduce significant complexity and administrative overhead, counteracting agile's original emphasis on simplicity and efficiency. Moreover, these frameworks can become rigid in practice, contradicting agile's emphasis on flexibility and continuous improvement. Finally, we recognize a risk that these frameworks might not align with the organization's specific needs, leading to poor adoption and limited benefits.

3. Results

3.1. RQ1: What Is the Distribution of Studies over the Last Decade?

As established in RQ1, we sought to characterize the evolution of studies over the last decade, as shown in Figure 2. Firstly, we note that the first studies on the adoption of hybrid approaches on a large scale only appeared in 2018. This indicates that it is a very recent area of study. There are also significant fluctuations in the number of publications between 2018 and 2024. The years 2021 and 2023 saw a total of 21 studies, which corresponds to 55.26% of all publications. In 2024, only publications up to the end of the 1st semester were counted.

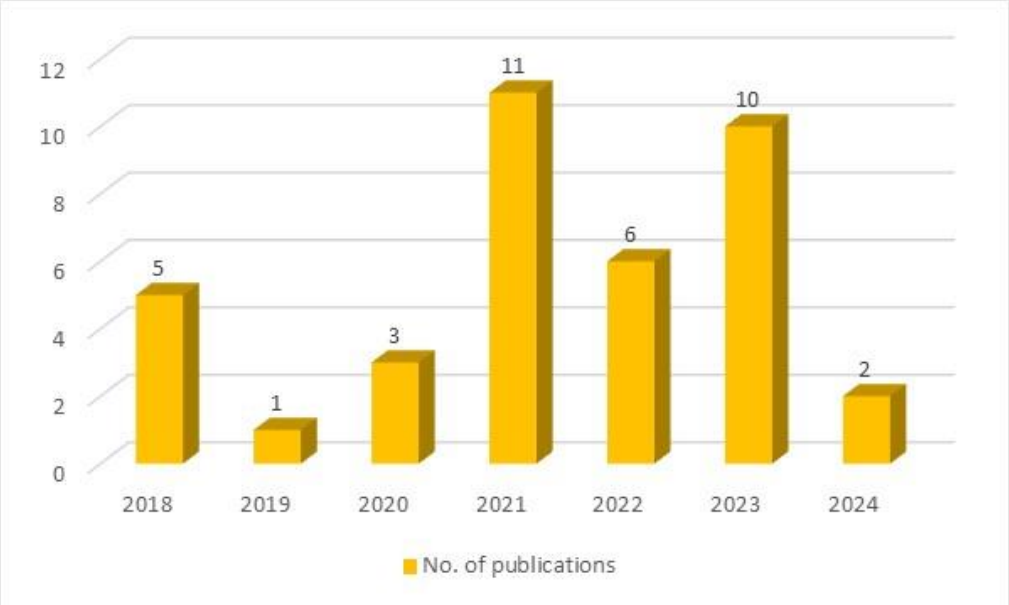

Figure 2. Evolution of publication frequencies in hybrid scaling of agile over time.

3.2. RQ2: Which Journals Have Published These Studies?

Table 1 lists the main journals where this research is published. Journals in the areas of software engineering, project management, and technology management stand out. The area of software engineering is of fundamental importance in modern society due to its central role in the development and maintenance of software systems that support practically all sectors of the economy. This area ensures that software is designed and implemented in such a way as to meet users' needs, be scalable and sustainable over time, and follow rigorous quality and security standards. Project management, on the other hand, is essential to ensure that software development projects are completed on time, within budget, and with the desired quality. Technology management covers the supervision and control of all technological aspects within an organization. This includes integrating new technologies, maintaining technological infrastructures, and ensuring that technological strategies are aligned with business objectives. In short, software engineering, project management, and technology management are interdependent areas that play crucial roles in the creation, implementation, and maintenance of technological solutions. Together, they aim to ensure that technological development is carried out effectively and sustainably. It should also be noted that most of the scientific publications are in other journals such

as Business Horizon, Information Systems Frontiers, IEEE Access, Sustainability, among others. These articles were published in 23 different journals.

Table 1. Frequency of publications in hybrid scaling of agile by journal.

Journal	N	%
Journal of Software: Evolution and Process	4	10.53
Journal of Systems and Software	3	7.89
Project Management Journal	2	5.26
IEEE Transactions on Software Engineering	2	5.26
IEEE Transactions on Engineering Management	2	5.26
Research Technology Management	2	5.26
Others	23	60.53

3.3. RQ3: What Level of Association Can Be Established between These Journals?

The association of scientific production in the journals is shown in Figure 3. Bibliographic coupling helps to answer RQ3, which is a method used in bibliometric analysis to establish a connection between two documents that cite a common third document. It assumes that if two documents cite the same references, they likely cover similar topics. The results complement the information previously found in RQ2 and identify a new cluster related to the thematic domain of information systems, which is more strongly related to publications in journals in the software engineering and project management fields than in the technological management field. Therefore, hybrid large-scale agile approaches are more strongly related to publications in journals within the software engineering and project management fields because these areas are inherently focused on the methodologies, tools, and processes needed to effectively develop and manage complex software projects. Information systems connect to software engineering through the need to translate business requirements into technical solutions, with SE providing the methodologies and practices for designing, developing, and maintaining these software solutions. Project management integrates with both fields by overseeing the planning, execution, and completion of projects, ensuring that software requirements are met through software engineering processes. Effectively, the interplay of these three fields ensures cohesive and efficient technology development and deployment.

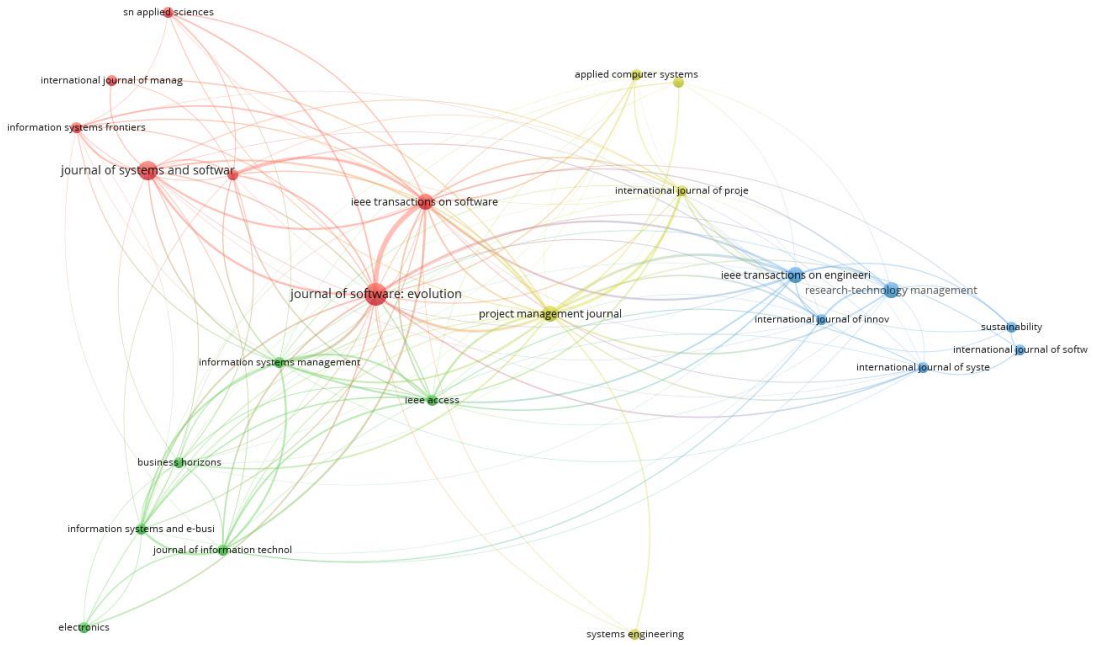

Figure 3. Network visualization of publications in hybrid scaling of agile by journal couplings.

3.4. RQ4: Which Research Methodologies Predominate?

Figure 4 provides an overview of the research methodologies adopted in these studies to answer RQ4. The findings indicate that most studies (55.26%) are qualitative, followed by quantitative studies (26.32%). Only two systematic reviews were found in the field, but they explore the adoption of hybrid approaches on a large scale from two different perspectives. Leong et al. [61] explore the integration of traditional project management methodologies with agile practices to enhance the sustainability of software development projects. It discusses the limitations of exclusively using either traditional or agile approaches and proposes a hybrid model that combines the structured, sequential processes of traditional methods with the flexibility and iterative nature of agile. Prenner et al. [62] examine the objectives and obstacles associated with combining traditional and agile methodologies in software development. It identifies the primary goals of hybrid approaches, such as enhancing flexibility, improving project adaptability, and leveraging the strengths of both traditional and agile practices to achieve better project outcomes.

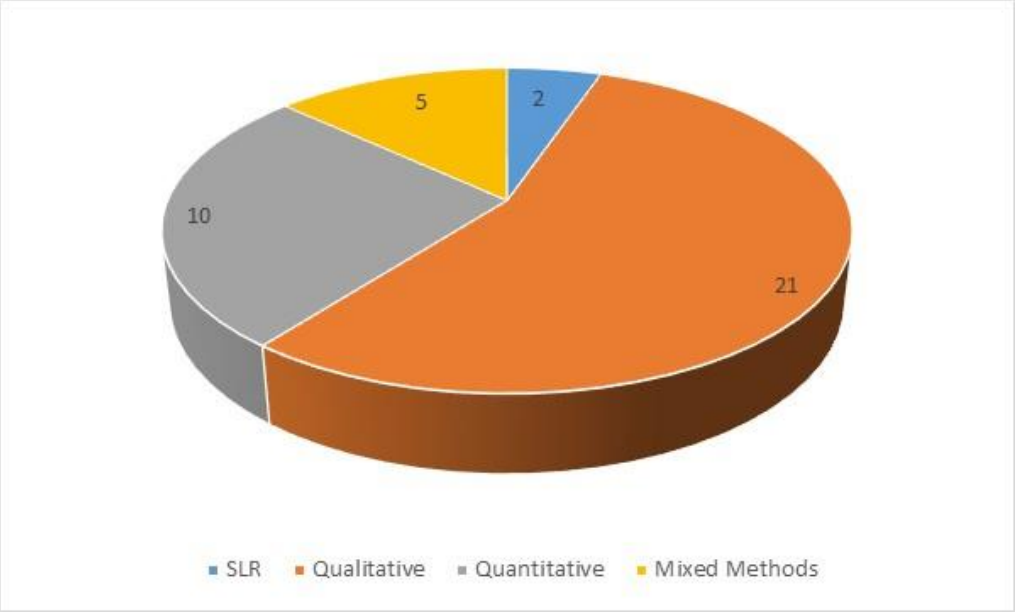

Figure 4. Research methodologies in hybrid scaling of agile used in the publications.

3.5. RQ5: What Network of Connections Is Established between the Key Terms of the Studies?

Figure 5 provides a vision about the network of connections established between the key terms to answer RQ5. This technique is relevant to understanding the relationships and connections between critical concepts within the body of literature. By mapping key terms, it becomes easier to identify dominant themes, emerging topics, and how specific ideas are interlinked. These key terms are based on the title and abstract. Structured abstract labels (when applicable) and copyright statements were ignored. A binary counting method was applied, which means that only the presence or the absence of a term in a document matters. Therefore, the number of occurrences of a term in a document is not taken into account. The most common terms are approach (n = 14), study (n = 12), project (n = 10), software development (n = 10), and practice (n = 10). Other relevant key terms with more than 5 occurrences are “agile”, “case study”, “project management”, and “practitioner”. These key terms suggest that this topic has a strong empirical component, carried out with organizations that implement these practices, and that it is difficult to generalize results. Hybrid approaches are often designed to fit the specific needs, constraints, and goals of a particular organization or project. This high degree of customization means that what works well in one organization may not be applicable or effective in another. Furthermore, the fields of project management and software development are also strongly related, as it

is necessary to analyze how large-scale team management practices lead to improvements in the software development process and team cohesion and performance.

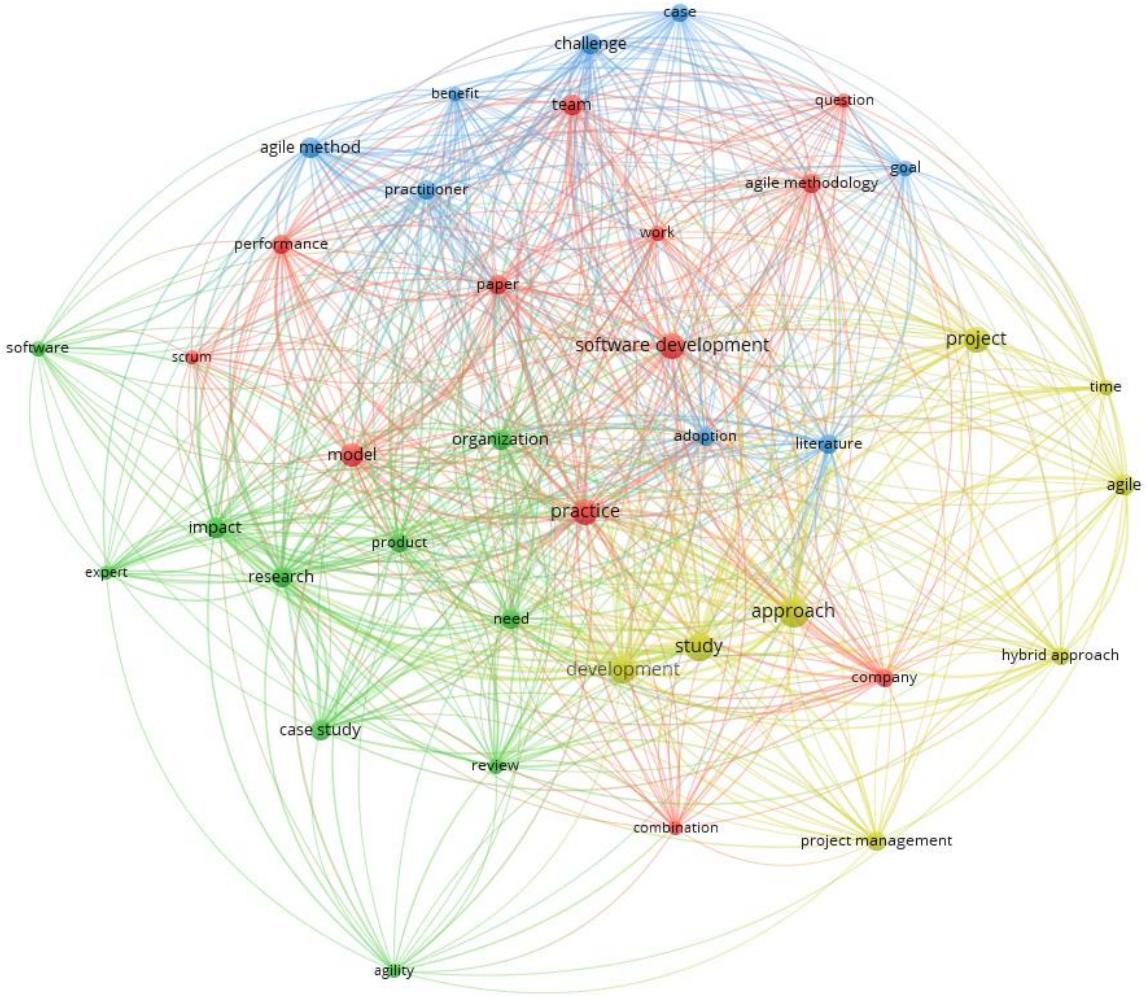

Figure 5. Network of connections between key terms in hybrid scaling of agile identified in publications.

3.6. RQ6: Which Clusters Are Identified among These Key Terms?

The response to RQ6 is given in Table 2. VosViewer performs cluster analysis using a technique called VOS (Visualization of Similarities), which is based on mapping and clustering co-occurrence data. It first constructs a similarity matrix from the input data, where entities (such as terms, authors, or citations) are represented by nodes. The strength of their relationships is calculated using co-occurrence or co-citation frequencies. Four clusters were identified. Each cluster provides information regarding the most frequent key terms, total number of occurrences (TNO), and total number of links (TNL). TNO refers to the frequency with which a particular term, keyword, or item appears in the dataset being analyzed. This metric is used to determine the prominence or significance of a term within the dataset. TNL represents the number of connections a particular term, keyword, or item has with other terms in the network. Each link signifies a co-occurrence relationship between two terms. This metric helps to understand the connectivity and relationships between different terms. Terms that belong to cluster I have the highest level of TNO and TNL. Findings suggest that case studies play a pivotal role in the practical application and understanding of large-scale agile methodologies. They provide real-world examples of how organizations navigate the complexities and challenges associated with scaling agile practices across multiple teams and departments.

Table 2. Thematic clusters in hybrid scaling of agile based on frequent key terms.

ID	Cluster	Frequent Key Terms	TNO	TNL
I	Methodology-focused cluster	agile methodology, combination, company, performance, practice, scrum, software development, team	71	381
II	Project-result-focused cluster	agility, case study, expert, impact, organization, product, software	54	308
III	Organization-focused cluster	adoption, agile method, benefit, challenge, practitioner	43	250
IV	Project-management-focused cluster	agile, approach, development, hybrid approach, project management	56	212

3.7. RQ7: Which Are the Different Hybrid Approaches Identified in Published Studies to Scale Agile?

Finally, the concept map presented in Figure 6 helps us to respond to RQ7. Hybrid scaling of agile aims to create a balanced environment where the flexibility and responsiveness of agile methodologies coexist with the rigor and discipline of traditional project management. This ambidextrous strategy is reflected in the concept map. Typically, traditional milestones offered by traditional project management (PM) methodologies such as costs and schedules control are incorporated. Moreover, the concept map identified that hybrid scaling of agile is strongly context-specific and needs to attend different decision-making processes that are requested by stakeholders. It shows that to effectively scale agile practices, different decision-making processes must be considered, as these processes are often shaped by the diverse needs and expectations of various stakeholders. This highlights the importance of flexibility and customization in implementing agile at scale, ensuring that the approach aligns with both the organizational environment and stakeholder requirements for success. Furthermore, the concept map reveals that hybrid scaling of agile relies on empirical process control, which emphasizes making decisions based on observation and evidence rather than predictions. This approach is grounded in three core principles: transparency, inspection, and adaptation. Transparency ensures that all aspects of the process are visible to stakeholders, providing a clear understanding of progress and challenges. Inspection involves regularly reviewing the process and outcomes to identify issues or opportunities for improvement. Adaptation allows for adjustments based on the findings from inspections, enabling the process to evolve in response to changing conditions or insights. Together, it can be concluded these principles support a flexible and responsive approach to scaling agile practices in different organizational contexts.

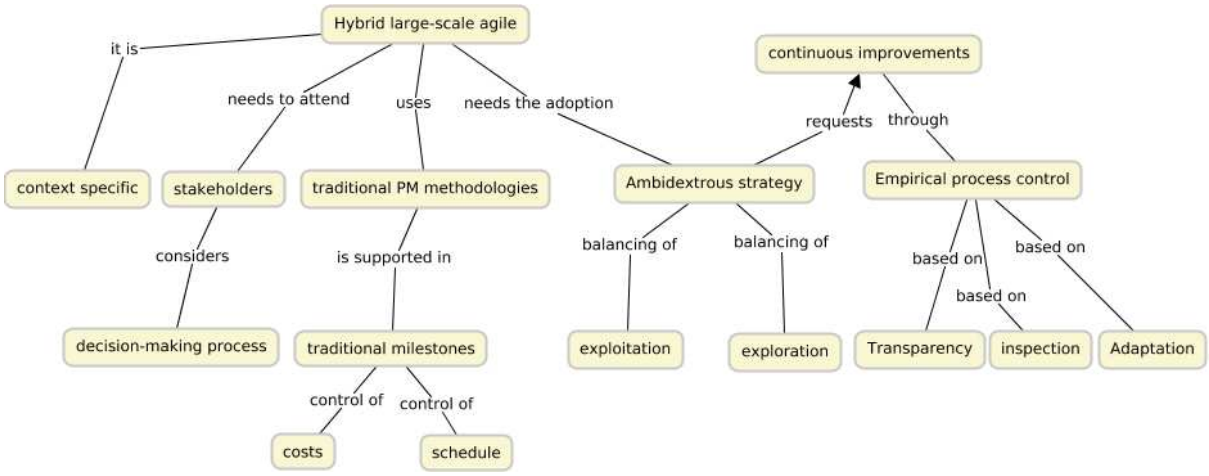

Figure 6. Concept map of hybrid scaling of agile based on the approaches identified in the publications.

4. Discussion

This SLR indicates that large-scale agile has become a prominent topic recently (see Figure 2) due to several converging factors in the evolving landscape of software development and organizational management. Initially, agile methodologies were developed to enhance flexibility and responsiveness in small and co-located teams. The literature in this field is vast and reported that these methods proved highly effective, fostering innovation and improving project outcomes [63–67]. As businesses increasingly relied on software and digital solutions, the need to scale agile practices across larger, more complex organizations became apparent. This interest has become more visible since 2021. One driving force behind the rise of large-scale agile is the digital transformation of industries, which increased its importance with the emergence of COVID-19. The urgency to maintain business continuity during the pandemic also highlighted the importance of resilience and adaptability. Organizations that had already adopted or quickly transitioned to large-scale agile practices found themselves better equipped to handle the disruptions caused by COVID-19. This resilience reinforced the value of scaling agile methodologies beyond small teams, advocating for their implementation across entire enterprises. At this point, some recommendations for practice can be established. First, organizations should tailor their agile scaling approach to their specific context, as hybrid scaling is not one-size-fits-all. This involves understanding the unique needs of the organization, its culture, and the nature of its projects, and then adapting agile practices accordingly. Decision-makers should ensure that key stakeholders are involved in defining the scaling strategy, as different stakeholders will have varying needs and expectations that can impact the success of the agile approach.

Qualitative studies, as depicted in Figure 4, emerge as the largest research methodology in this field. Case studies and practical approaches are predominant in large-scale agile studies because they offer tangible, real-world insights that theory alone cannot provide. Agile methodologies, by their nature, emphasize practical application and iterative improvement over rigid adherence to a predefined set of rules. This practical focus makes case studies particularly valuable as they demonstrate how these methodologies can be adapted and implemented in diverse, complex organizational settings. Furthermore, case studies provide detailed narratives that showcase the specific strategies, techniques, and tools used by organizations to overcome these challenges. These stories allow practitioners to learn from the successes and failures of others, offering guidance that is grounded in real experiences rather than abstract concepts. This observation is supported by studies such as Schüll et al. [68] and Trippensee and Remané [69], which also highlight that practical approaches in large-scale agile studies help bridge the gap between theory and practice. While theoretical frameworks provide a foundation for understanding agile principles, it is through practical applications that these principles are tested and refined. Real-world examples illustrate how theoretical concepts can be customized to fit the unique needs of an organization, considering factors such as company culture, industry requirements, and team dynamics.

The findings of this SLR point to the high relevance of implementing an ambidextrous strategy as provided in Figure 6. An ambidextrous strategy refers to an organizational approach that effectively balances two seemingly contradictory activities: exploitation and exploration. Exploitation involves leveraging existing capabilities, resources, and market positions to maximize current performance and efficiency. Ambidextrous strategies recognize the importance of both exploiting current strengths and exploring new possibilities to sustain long-term success and competitiveness in dynamic environments. It can be assumed that an ambidextrous strategy is highly relevant in the context of hybrid scaling of agile for several reasons. Large organizations that adopt hybrid agile methodologies at scale often need to exploit existing capabilities and resources efficiently while simultaneously exploring new ideas, technologies, and market opportunities. Exploitation ensures that these organizations leverage their current strengths and maximize the value delivered through stable, well-established processes. Exploration within hybrid scaling of agile should encourage innovation and adaptability. Balancing exploitation and exploration in

hybrid scaling of agile aims to ensure that the organization remains resilient and responsive in a dynamic business environment.

In the context of hybrid scaling of agile, where projects often involve multiple teams, diverse stakeholders, and interconnected dependencies, continuous improvement and empirical process control emerge as core elements in the process of scaling agile through hybrid approaches as revealed by Figure 6. Continuous improvement in hybrid scaling of agile ensures that teams and the organization as a whole are constantly striving to enhance their processes, practices, and outcomes. Therefore, it is recommended that organizations follow continuous learning and adaptation throughout the scaling process. Accordingly, organizations should implement mechanisms for regular feedback, allowing teams to inspect and adjust their processes based on empirical data. This approach, rooted in transparency, inspection, and adaptation, ensures that the scaling of agile practices remains flexible and responsive to changing conditions. Agile methodologies like Scrum and Kanban emphasize iterative and incremental development and regular retrospectives. A good example of the application of this methodology on a large scale is using the Scrumban model. Scrumban is characterized by Alqudah and Razali [70] as a hybrid agile methodology that combines elements of Scrum and Kanban practices to create a flexible approach to managing work in teams, which emerged particularly in software development and other knowledge work industries. In Scrumban, teams typically maintain a Kanban board that visualizes their workflow stages (e.g., backlog, in progress, testing, done) and limits WIP to improve flow and efficiency. They also incorporate Scrum ceremonies like stand-ups for daily coordination and retrospectives for continuous improvement. Unlike Scrum, Scrumban does not strictly enforce fixed-length sprints; instead, it allows for continuous flow of work based on priorities and capacity. Therefore, it can be concluded that Scrumban's flexibility makes it ideal for scaling agile practices across larger, more diverse teams, especially when there's a need to balance predictability with responsiveness to change. Another example is the Agile DAD model. It is based on the principles of flexibility and pragmatism, allowing teams to select and tailor agile practices based on the specific needs of their projects. It acknowledges that not all projects are the same and provides guidance on how to apply agile principles effectively in diverse situations, including complex enterprise environments. The model has two important characteristics: (i) it encourages teams to tailor their approach based on the project context; and (ii) it supports a hybrid approach by integrating agile practices with other methodologies and frameworks (e.g., Lean, Scrum, Kanban) as needed. A tailored example of agile DAD is provided by Cooper [71] with the proposed Agile–Stage-Gate Hybrid Model. It combines agile principles with the Stage-Gate process, creating a structured approach to managing innovation and product development projects.

5. Research Agenda

Establishing a research agenda for hybrid scaling of agile involves identifying key areas where further exploration and investigation can contribute to enhancing understanding, improving practices, and addressing challenges in agile implementation at scale. This study has observed that many studies focus on the practical implementation and outcomes of the methodologies rather than on the theoretical classification of the approach as hybrid. As such, the term "hybrid" may be considered less important or relevant to the practical aspects being reported. Furthermore, in practice, organizations may use hybrid approaches without labeling them as such, simply referring to them by the main framework or methodologies involved.

The first point of future research is exploring the role of organizational culture in successful agile transformations at scale. It is important to investigate how hybrid approaches integrate with traditional hierarchies, roles, and reporting lines. This involves studying new organizational structures that emerge to support agility, such as cross-functional teams and flexible governance models. A forked research line is pointed out by Porkodi [72] that aims to explore the role of leadership in driving cultural change towards agile values

and practices is essential. It is assumed that human aspects of agile transformation are key for organizations. In this research line, we propose studying the effects of agile on employee motivation, job satisfaction, and collaboration dynamics. Investigating effective change management strategies that facilitate the transition to hybrid scaling of agile is vital, considering factors such as communication, training, and stakeholder engagement.

Exploring factors that influence team dynamics and collaboration in hybrid scaling of agile is another point of our proposed research agenda. This involves studying how teams composed of both co-located and distributed members collaborate, communicate, and coordinate tasks [73]. Therefore, we plan to conduct case study research that could understand the challenges and benefits of mixing physical and virtual teamwork environments to provide insights into how team performance could be optimized.

Another point that could be better explored is how technical practices (e.g., DevOps, continuous integration/continuous deployment) and architectural decisions impact the scalability process. This can be divided into several specific research topics. Firstly, investigating the impact of architectural patterns (e.g., microservices, serverless) on scalability is relevant [74]. Research should explore how these architectures enable flexibility, scalability, and resilience in large-scale agile projects. Secondly, studying the integration of technical practices such as DevOps, continuous integration/continuous deployment (CI/CD), and test automation within hybrid large-scale agile approaches is crucial [75]. Research could examine how these practices streamline development processes, enhance collaboration between development and operations teams, and accelerate the delivery of high-quality software. Thirdly, exploring the role of emerging technologies (e.g., artificial intelligence, blockchain) in augmenting agile practices and supporting scalability is important [76,77]. Research could investigate how these technologies can be leveraged to automate repetitive tasks, improve decision-making processes, and enhance the security and reliability of agile deployments.

Finally, hybrid scaling of agile should consider its application in different industries. This research line involves exploring how agile methodologies can be adapted and optimized to meet diverse industry-specific challenges and requirements. We aim to investigate how regulatory frameworks, market dynamics, and customer expectations shape the implementation and scalability of agile practices. Comparing agile implementations in industries (e.g., healthcare, finance, manufacturing, and technology) like reported in studies such as Hüllmann et al. [78] and Kokol [79], can provide insights into sector-specific barriers and opportunities for agile transformation. It is also suggested to investigate the impact of agile on business outcomes and competitive advantage across industries in the context of scaling agile initiatives. Research could evaluate how agile methodologies contribute to innovation, time-to-market reduction, and customer satisfaction in sectors with varying degrees of technological maturity and market volatility [80]. Understanding the relationship between agile implementation maturity and organizational performance metrics (e.g., ROI, employee satisfaction) in different industries will provide benchmarks and success factors for agile adoption in the context of large-scale environments.

6. Conclusions

The authors acknowledge that an SLR on hybrid scaling of agile in IT industries can provide several significant theoretical contributions to the field of agile project management and organizational behavior. Firstly, it offers a comprehensive synthesis of existing research, consolidating diverse perspectives and empirical findings into a unified framework. This synthesis helps identify common themes, contradictions, and gaps in the literature, thereby establishing a clearer understanding of the current state of knowledge. Furthermore, this SLR contributes to theory-building by presenting the factors that influence the adoption, implementation, and effectiveness of hybrid agile approaches in large-scale settings. The systematization of various theoretical perspectives from organizational theory, agile methodology, and the project management literature helps to understand how integrative models could be proposed with the objective of enhancing our understanding of

how different organizational contexts, cultural factors, and project characteristics interact with agile principles. Furthermore, this study highlights the evolution and adaptation of agile methodologies in response to the challenges posed by scaling them to larger projects and organizations. This evolutionary perspective contributes to theories of organizational change and adaptation, illustrating how agile principles are modified and extended to fit the complexities of large-scale projects.

It is also important to highlight the practical contributions offered by this SLR. Firstly, it provides a consolidated view of best practices and lessons learned from a wide range of case studies and empirical studies. This synthesis helps practitioners understand the diverse strategies and approaches organizations have used to successfully implement hybrid scaling of agile, offering practical insights into what works and what does not in different contexts. Secondly, this study can highlight specific methodologies, frameworks, or tools that have been effective in supporting hybrid agile practices at scale. This practical guidance is particularly valuable for project managers and agile coaches seeking to enhance their toolkit with proven techniques and tools that facilitate collaboration, communication, and coordination across large teams and complex projects. Moreover, this work provides practical recommendations for organizational change management and cultural adaptation necessary for transitioning to hybrid scaling of agile approaches.

Finally, it is relevant to note some limitations of this study. This SLR only considered publications in journals, so it could also have used publications in conferences which typically have less theoretical impact but may reveal interesting insights into these hybrid implementations. Another limitation is that there was no comparative analysis of the different approaches. The development of these approaches is also considered to have been a lengthy process of continuous improvement. It would be interesting to trace the process of tailoring these approaches and how the continuous improvement processes were implemented. Another point not identified in this SLR was the measurement of the outcomes of these implementations which can be explored from multiple perspectives such as process success rates, improved team cohesion, improved work processes, reduced delivery times, among others.

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Appendix A

Table A1. List of the documents included in this SLR.

ID	Document	Year	DOI
S1	Applying standard independent verification and validation techniques within an agile framework: Identifying and reconciling incompatibilities	2019	10.1002/sys.21487
S2	Scaling for agility: A reference model for hybrid traditional-agile software development methodologies	2018	10.1007/s10796-016-9672-8
S3	Coordination Challenges in Large-Scale Software Development: A Case Study of Planning Misalignment in Hybrid Settings	2018	10.1109/TSE.2017.2730870
S4	SAM: Preliminary Hybrid Model to Support Agile Large-Scale Transformation in Software Industries	2020	10.19053/01211129.v29.n54.2020.11763

Table A1. *Cont.*

ID	Document	Year	DOI
S5	Managing the Hybrid Organization: How Can Agile and Traditional Project Management Coexist?	2021	10.1080/08956308.2021.1843331
S6	Scalable Agile Frameworks in Large Enterprise Project Portfolio Management	2023	10.1109/ACCESS.2023.3312728
S7	A framework for modeling structural association among De-motivators of scaling agile	2021	10.1002/smr.2366
S8	Remote agile: Problems, solutions, and pitfalls to avoid	2023	10.1016/j.bushor.2022.10.003
S9	What Makes Agile Software Development Agile?	2022	10.1109/TSE.2021.3099532
S10	Large scale quality transformation in hybrid development organizations—A case study	2021	10.1016/j.jss.2020.110836
S11	Towards the statistical construction of hybrid development methods	2021	10.1002/smr.2315
S12	Agile, Traditional, and Hybrid Approaches to Project Success: Is Hybrid a Poor Second Choice?	2021	10.1177/8756972820973082
S13	Issues and challenges impacting the successful management of agile-hybrid projects: A grounded theory approach	2021	10.1016/j.ijproman.2021.03.002
S14	Designing an Agile, flexible and resilient disaster supply chain network using a hybrid group decision-making robust optimization framework	2023	10.1016/j.cie.2023.109591
S15	Quality culture boosts agile transformation—Action research in a business-to-business software business	2023	10.1002/smr.2504
S16	The nexus of project management approaches in sustainable development: innovative behaviors as a mechanism in the Polish financial industry	2024	10.1108/IJMPB-09-2023-0219
S17	Characteristics of self-managing teams in rapid product development projects	2018	10.1504/IJVCM.2018.091097
S18	Providing a model of LeAgile hybrid paradigm practices and its impact on supply chain performance	2022	10.1108/IJLSS-04-2021-0073
S19	An Orchestration Framework for Digital Innovation: Lessons From the Healthcare Industry	2023	10.1109/TEM.2022.3167259
S20	From transformation to normalization: An exploratory study of a large-scale agile transformation	2023	10.1177/02683962231164428
S21	Job-work fit as a determinant of the acceptance of large-scale agile methodology	2020	10.1016/j.jss.2020.110577
S22	Large-Scale Agile Project Management in Safety-Critical Industries: A Case Study on Challenges and Solutions	2024	10.1080/10580530.2024.2349886
S23	Reporting in large-scale agile organizations: insights and recommendations from a case study in software development	2023	10.1007/s10257-023-00643-1
S24	Estimation of software quality parameters for hybrid agile process model	2021	10.1007/s42452-021-04305-0
S25	Expert Survey on Current Trends in Agile, Disciplined and Hybrid Practices for Software Development	2021	10.2478/acss-2021-0005
S26	Hybrid Project Management between Traditional Software Development Lifecycle and Agile Based Product Development for Future Sustainability	2023	10.3390/su15021121
S27	Structured software development versus agile software development: a comparative analysis	2023	10.1007/s13198-023-01958-5
S28	Dysfunctional Agile–Stage-Gate Hybrid Development: Keeping Up Appearances	2022	10.1142/S0219877022400041
S29	MFPP: Matrix-based flexible project planning	2022	10.1016/j.softx.2022.100973
S30	The impact of tailoring criteria on agile practices adoption: A survey with novice agile practitioners in Brazil	2018	10.1016/j.jss.2017.12.012
S31	Goals and challenges in hybrid software development approaches	2021	10.1002/smr.2382
S32	XPS-MoSCoW: A Prioritization-Based Hybrid Agile Model of SCRUM and Extreme Programming	2022	10.4018/IJSI.297989
S33	Agile-Concurrent hybrid: A framework for concurrent product development using Scrum	2020	10.1177/1063293X20958541

Table A1. *Cont.*

ID	Document	Year	DOI
S34	Agile–Stage-Gate for Manufacturers	2018	10.1080/08956308.2018.1421380
S35	Enhancing Hybrid OSS Development Through Agile Methods and High Media Synchronicity	2021	10.1145/3508484.3508490
S36	Agile Software Development and Reuse Approach with Scrum and Software Product Line Engineering	2023	10.3390/electronics12153291
S37	Recommendation of Project Management Practices: A Contribution to Hybrid Models	2022	10.1109/TEM.2021.3101179
S38	The Role and Characteristics of Hybrid Approaches to Project Management in the Development of Technology-Based Products and Services	2021	10.1177/8756972820956884

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