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Agile Transition and Adoption Frameworks, Issues and Factors: A Systematic Mapping

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ABSTRACT In order to adopt specific agile methods and to accommodate lean principles, many organizations need to tailor their processes. Different frameworks supporting and guiding the agile transition and adoption process exist in the literature. However, there is a demand for specific guidelines on the different circumstances influencing agile adoption. This paper provides a Systematic mapping of the available frameworks, issues and factors affecting a successful agile transition and adoption process. Twenty-eight primary studies have been considered. The results are presented according to the three research questions. Firstly, nine systematic approaches and frameworks for agile transition and adoption are analyzed. Secondly, different issues related to the agile transition and adoption process are gathered, compared and synthesized in the following five categories: pre-transformation activities, obstacles and results, stages and activities, agile practices and situational factors. Finally, a list of 154 situational factors affecting the agile transition and adoption process is proposed.

INDEX TERMS Agile software development, agile transition and adoption, systematic mapping.

I. INTRODUCTION

Agile methods for software development have been increasingly used in the Information Technology sector [1]–[3]. The publication of the Agile Manifesto back in 2001 made public the fundamental principles of agile [4], thus making a significant step towards a wider use of agile methods in organizations. Dyba and Dingsoyr [5] developed a systematic literature review (1996 to 2005) on agile software development that underlined the interest of the industry in the Agile Manifesto more than a decade ago. In their research, four research topics were identified: agile adoption, human factor, perception and comparative studies. The adoption of agile methods influences positively on software development organizations in tailoring their services and products, and in increasing their capability to accommodate and respond to the market trends [6]–[8].

Significance of agile process tailoring is well recognized [9]–[11]. However, tailoring process steps are not widely reported in the literature [7] given that are very reliant on the company context. Agile adoption process strongly depends also in specific aspects like organizational environment and culture. Agile practices and methods often have to be customized and tailored to accommodate specific situational factors in order to be integrated in the already established company processes [1], [12]. In this paper, we will use the term situational factor to refer to individual characteristics or circumstances of each setting that affect the deployment of a process. Agile process tailoring involves a disciplined and well organized endeavor as any other plan driven method [13].

Many researchers have identified obstacles in the agile adoption process. Challenges of the agile adoption process may be related to the development process, customer issues, developer and management issues, organizational issues, technical issues, human related issues or to inadequate and dysfunctional training [7], [14], [15]. Different practices and strategies may be used to address the identified specific issues [7], [16] and to overcome the identified problems [17]–[19].

The objective of this study is to systematically analyze the existing literature on agile tailoring and adoption process.

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As a result, the authors would like: 1) to compare the existing agile adoption frameworks, issues and situational factors influencing the agile transition process, and 2) to identify trend gaps in the existing research. Systematic mapping was chosen as the research method for this study to allow evidence gathering on the agile method adoption and transition process.

The rest of the paper is structured as follows. Section II provides related work and background to agile transition and adoption frameworks, issues and factors. In Section III, authors present a detailed description of the research method used in the study, the systematic mapping. Following that, in Section IV, the results of the research conducted are detailed. Discussion of results is provided in Section V. Section VI collects threats to validity and limitations of this study. Conclusions and future work are presented in Section VII.

II. BACKGROUND AND RELATED WORK

In order to satisfy the rising expectations of the clients demanding innovative and high quality software meeting business needs, agile software development is seen as a valid response to this need. Agile methods offer an attractive alternative to traditional approaches. After several decades of traditional software development methods, agile methods provided new values to organizations such as fast delivery, customer satisfaction, improved quality, cost of change reduction and decreased documentation [9], [20].

The Agile Manifesto was based on methods like Extreme Programming (XP), Scrum, Dynamic systems development method (DSDM), ASD, Crystal, Feature-Driven Development or pragmatic programming [20]. For the Manifesto, a group of experts compared these agile methods and synthesized the basic principles underlying iterative software development. In this regard, four basic values encapsulating the agile methods were derived: individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and responding to change over following a plan [9]. The previously mentioned agile methods are organized around different processes and embed diverse sets of activities and practices, but values defined in the Agile Manifesto represent the backbone of all agile methods.

Even though agile methods differ to a certain extent, they may be combined and integrated as well, as shown in the study conducted in Intel Shannon [13], a success story of two methods integration (XP and Scrum). In this research, it was concluded that XP is oriented towards technical (hard) aspects, while Scrum is towards management (soft) aspects of software development. In [21], [22] successful examples of incorporating agile practices (XP) in a plan driven context are demonstrated, and different aspects on people, management and organization are defined. Binder *et al.* [23] present a hybrid approach balancing the structure of waterfall-based models with the flexibility of agile principles. Torrecilla-Salinas *et al.* [22] propose a framework addressing the main characteristics of estimation and management in web development projects, by offering a balance of agility and stability to plan and control project constraints. Another hybrid approach of incorporating a quantitative scheduling model, implicating the agile development to become more plan driven is presented by Jahr [24]. In this work, the Bridge method is used to balance the portfolio of agile and formal process practices [25], [26]. In [27] it was concluded that agile methods provide powerful tools for microplanning within stages and that, in turn, stage-gate models enable better communication with other departments and organizational levels or even the external environment to the project. In the same manner, Scrum/stage-gate hybrid model shows integration of Scrum in the product development processes derived from five case studies [28]. Hybrid models combining stage-gate and agile practices may be used beyond software industry, and their use improves several aspects of project and product development performance such as information accuracy, commitment and leadership [27], [29].

Specific procedures are needed to support the successful deployment of agile practices and to perform a systematic selection, deployment and agile method tailoring, depending on the specific situation of the adopting organization [30]. Different agile transformation scenarios may be identified: incremental, big-bang, incremental from agile practices towards plan driven, tailoring of highly complex processes and coexistence of both agile and plan driven methods meaning agile practice adoption [31].

Agile transition is an issue to be further investigated by research communities [32]. Different challenges arise when agile practices are applied in organizations [8], [33]. Different enablers, means and factors influencing the organizational agility may be identified [34], [35]. One of the main interests of the authors of this paper is to identify which are these challenges, enablers and factors affecting the agile adoption. Apart from being familiar with the factors to consider when agile adopting, organizations need to know how to perform process tailoring [36]. Since agile methods do not offer clear guidelines on how to implement each best practice, different artefacts can be customized to the particular needs of the organization [37], [38]. Moreover, agile coaching to support agile adoption process is often perceived costly, but helpful and valuable on the other hand [39]. Similarly, the definition of communities of practice as a facilitator of the agile transformation process is not considered effortless [40], [41].

Some authors have created and elaborated frameworks supporting agile transition and adoption process. Agile adoption frameworks, as an attempt to synthetize and conceptualize the agile transformation process in the organization, propose different guidelines and focus on different situational factors to be observed and assessed before, during and after the agile transition process. The identified frameworks for agile adoption offer different approaches: practices used to overcome identified challenges, agile method suitability for different types of environment, factors influencing the acceptance of agile methods, general strategies for agile method adoption, tools for matching agile practices with the corporate

strategy, criteria for tailoring multiple methods to specific needs in the organization, analytical toolkits to be used by managers as an assistance during the transformation process and facilitators, or prerequisites and key issues and challenges to the agile adoption [7], [30], [42]–[46]. Taking this into account, another main research goal of the authors of this paper is to identify, analyze and compare all the existing frameworks to support agile transition and adoption.

Finally, it is necessary to provide organizations with tools to assess the success of agile transformation [47], [48]. Different observations may be found in the literature regarding the agility level achieved and the suitability of agile method tailoring to specific circumstances. Objectives, principles and practices may be used as a guidance for assessing to which extent a customized agile method supports organizational strategy [2], [49]. The Project Management Office needs to become agile itself to support the transformation. Metrics that could be used for measuring the success of projects after transformation are: time to market, customer satisfaction and value delivered per release [50]. In the study of Gren *et al.* [51], first level of the agility measurement tool proposed by Sidky *et al.* [45] was used and they concluded that this instrument may be used for measuring organizational agility and go/no go decisions for agile transformation process. Available assessment models in the literature evaluate different aspects with regards to agility, for instance, in [52] authors present a four-stage assessment model including: company management agility assessment, project agility assessment, team agility assessment and workspace agility coverage. One way of measuring the agility of software development in practice is to measure the compliance of business processes with the four fundamental principles of the Agile Manifesto [53]. The study of Korhonen [54] presents a case of longitudinal case study of agile transformation in Nokia Siemens Networks and may be used as a reference for other companies interested in the evaluation of the impact of transformation. Further contribution to measuring agile transformation is done by Olszewska et al. [55], where eight quantitative metrics evaluating the transformation was proposed.

From this literature review, the authors of this paper have been able to conclude that agile method integration, both in agile and in plan-driven contexts, has been further studied and proved. However, there is a lack of awareness of the factors to consider when agile adopting. Moreover, specific guidelines to support agile method tailoring depending on the situation of each organization are still needed.

III. RESEARCH METHOD

Systematic mapping studies represent a sound way to shed light on an area of research by systematically classifying all the contributions in literature with regards to an already established taxonomy. In the case of this paper, it was adopted to study agile adoption and transition processes. The selected research method is a proven mean to arrive at detailed census of existing research in the domain.

The systematic mapping was carried out following the guidelines proposed by Petersen *et al.* [56]. The systematic mapping activities followed in this research are described in the next sub-sections.

A. RESEARCH QUESTIONS

Contributions to the research topic at hand may be found in different domains such as software development methods and processes (organizational and technical aspects), project management methods (traditional, agile and hybrid) and change management (aspects of organizational change).

A first objective of this research was to investigate which frameworks designed to guide the move from traditional (also referred to as plan driven or stage-gate) to agile software development exist in the literature (RQ1 in Table 1). The second research objective was to explore, analyze and synthesize issues, aspects and situational factors affecting the transformation process from traditional to agile software development, which was stated in the second and third research questions (RQ2 and RQ3 in Table 1).

TABLE 1. Research questions.

ID	Research question
RQ1	Which frameworks for agile transition and adoption exist in the literature?
RQ2	Which issues and aspects are discussed in agile transition and adoption literature, and how can they be grouped and organized?
RQ3	Which are the situational factors affecting agile transition and adoption process?

The RQ1 aimed to identify frameworks and methodological approaches toward agile adoption, while specifying challenges, transformation objectives, transformation maturity levels, set of steps, change process guidelines and other aspects discussed in the literature. The first research question considers different initiatives of the company's transition to agile method or practice adoption, also named in the literature as agile process tailoring or agile transition or transformation process. The previously mentioned initiatives in the literature discuss different approaches and strategies to agile transformation process and focus on various but specific aspects (method as a whole, adoption of practices, artefacts and roles). The intention of the researchers of this study was to review available frameworks and methodological approaches in the aforementioned initiatives.

The objective of the RQ2 was to provide a broader view of the agile transition process by identifying issues and aspects that should be considered when performing an agile adoption initiative in an organization. Elements and classifications identified in primary studies have been analyzed to investigate if they may be organized in a logical way (high-level groupings).

The intention of the RQ3 was to identify the situational factors affecting the agile transformation process in an organization. The frameworks identified as a response to the RQ1 were

analyzed to explore different factors embedded in the frameworks and systematic approaches. In addition, the intention was to involve additional studies contributing to identifying more situational factors in agile tailoring initiatives, software development processes or agile method adoption process. Firstly, studies offering explicitly stated situational factors were reviewed, but also other studies where situational factors were implicitly stated were taken into account.

Therefore, the research focus of this study is to gather, analyze and synthesize available discussions and perspectives on agile transition and method adoption: frameworks, tailoring criteria and situational factors among other aspects. The RQ1 aimed to identify frameworks and systematic approaches towards agile adoption process, the objective of RQ2 was discovering issues and aspects affecting the agile transformation process and the RQ3 is focused on identifying specific situational factors.

B. SEARCH

After defining our research questions, a formal search strategy to identify all the available materials within the scope of the research objectives was defined: what to search for and where. Hence, search terms and strings were defined (Table 2) and digital scientific repositories were identified (Table 3).

TABLE 2. Search strings.

ID	Search string
1	"agile" AND ("adoption" OR "transformation" OR "transition" OR "tailoring") AND ("framework" OR "process" OR "issues")
2	("scrum" OR "XP") AND "practice adoption"
3	("agile" OR "software") AND "development" AND ("methods" OR "factors")
4	"agile" AND ("software development" OR "scaling OR "method engineering" OR "hybrid methods")
5	"agile" AND "hybrid" AND ("methods" OR "tailoring")
6	"agile" AND ("practice" OR "method") AND ("selection" OR "adoption" OR "tailoring" OR "customization" OR "issues")

TABLE 3. List of sources.

ID	Source
1	ACM Portal (Digital Library and Guide)
2	IEEE Xplore
3	Springer Link
4	ScienceDirect
5	Willey InterScience – Wiley Online Library
6	CiteSeerX
7	IET Digital Library
8	ISI Web of Knowledge

With regards to search string creation, authors started with a broad search string adjusted to RQs by means of keyword derivation. Authors ran several pilot searches and adapted some terms from the search string. The process produced a general search string that was later tailored to each of the selected sources.

Brereton *et al.* [57] identified electronic databases relevant for performing an exhaustive research in the software engineering domain. The proposed list was used as a basis and three more databases (the ones with IDs 3, 5 and 7 in Table 3) were added to the list. Search of publications was performed through the list of sources (electronic databases) shown in Table 3.

C. STUDY SELECTION AND QUALITY ASSESSMENT

The screening of papers was performed through a search of research articles in scientific journals and conference proceedings from the sources specified in Table 3. Six inclusion criteria (IC) and two exclusion criteria (EC) for the study screening process were defined by authors and they are presented in Table 4.

TABLE 4. Studies inclusion (IC) and exclusion criteria (EC).

ID	Criterion
IC1	Qualitative and quantitative studies.
IC2	Papers written in English.
IC3	Papers containing keywords matching with those defined in the search strings.
IC4	Papers whose abstract is related to the topic under consideration.
IC5	Papers related to systematic approach towards agile transition and/or transformation and/or adoption process.
IC6	Papers presenting generic frameworks, not related to one specific company or to one concrete situation.
EC1	Papers not covering agile methods, practices or processes, tailoring or transformation in software development.
EC2	Editorials, prefaces, article summaries, news, reviews, reader's letters, panels, posters.

The screening of papers was carried out through four sequential research stages, which are shown in Fig. 1. Different research activities were performed in each stage and sample size of the studies was reduced to the final selection of the primary studies.

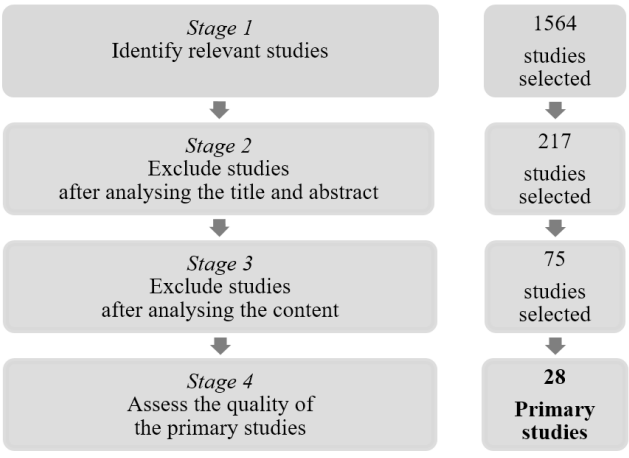

FIGURE 1. Primary study selection process.

During the first research stage, the electronic repositories listed in Table 2 and the search strings presented in Table 1 were used to make a complete set of queries. Stage 1 was performed by the first author. As a result of the initial search of electronic databases, 1736 research studies

were obtained. In the same research stage, duplicates were removed which further decreased the number of the studies by 172. Finally, 1564 studies were considered relevant for further analysis.

In the second stage, the sample size was further reduced based on the analysis of titles and abstracts. Inclusion and exclusion criteria were guidelines for further selection of the papers. The aim of this stage, carried out by the first, second and third authors, was to include relevant papers presenting a systematic approach to agile transition process and process tailoring, and to identify frameworks and guidelines and/or situational factors influencing the change process. Studies focusing only on one agile or traditional method being used in the organizations were not included in the study since the intention was to gather either generic approach towards software development and process tailoring, or concrete activities and tools to be used for agile adoption process in the organizations. Authors focused only on studies published on journals and conferences, whereas summary articles, experience reports and poster sessions were excluded. After performing the second research stage 217 publications were considered relevant for further analysis.

A detailed analysis of the studies was performed in the third research stage by the first, second and third authors. At this point in time, introduction and conclusions of each paper were reviewed in detail, and if needed rest of the paper's sections were analyzed as well. The research aim at this stage was to identify the discussed frameworks and systematic approaches, aspects and situational factors affecting the agile transition and adoption process. Framework or situational factors had to be given explicitly, like for instance: "*The framework highlights that agile practices are adapted and appropriated based on the project, organizational, and development context. Our findings include a set of appropriated practices that are shaped by various sources of structures and address several challenges in process adaptation.*" [7]. After this research stage, the study number decreased to 75.

During the last research stage, quality assessment was performed on the 75 pre-selected studies by all the four authors. The criteria used for quality assessment, which are shown in Table 5, were adapted from [6] to suit the research questions and goals of this paper. With C1, authors evaluated if the research objective was clearly given and backed up by industry or existing theory. With C2 and C3, we wanted to see if context information was sufficiently given and the research design was well prepared. C4 assessed the sufficiency of data collection methods, instrument and measures. Besides, with C5 we wanted to see if the constructs and measures addressed the given research objective. C6, C7 and C8 evaluated if the data analysis was properly reported. For a quantitative study, authors checked if effect sizes and statistical significance were reported. For a qualitative study, we checked if the interpretation of qualitative evidences, such as interview quotes or observation field notes were given. Finally, with C9 we assessed if the outcomes were clearly documented and if the study threats of validity were sufficiently analyzed (C10).

TABLE 5. Criteria for quality assessment.

ID	Criterion for quality assessment
Problem statement	
C1	Is research objective sufficiently explained and well-motivated?
Research design	
C2	Is the context of study clearly stated?
C3	Is the research design prepared sufficiently?
Data collection	
C4	Are the data collection and measures adequately described?
C5	Are the measures and constructs used in the study the most relevant for answering the research question?
Data analysis	
C6	Is the data analysis used in the study adequately described?
C7a	Qualitative study: Are the interpretation of evidences clearly described?
C7b	Quantitative study: Are the effect size reported with assessed statistical significance?
C8	Are potential alterative explanations considered and discussed in the analysis?
Conclusion	
C9	Are the findings of study clearly stated and supported by the results?
C10	Does the paper discuss limitations or validity?

For each criterion the studies met, authors rated the study as 1, and otherwise 0. This means that the maximum score a paper could get was 10. A score of 0–4 was regarded as low rigor, 5–7 medium rigor and 8–10 high rigor. The 28 high rigor studies were considered as primary studies in this paper. Krippendorff's alpha was first applied in content analysis as a reliability coefficient. It measures the agreement among observers, coders or judges. In systematic mappings it is used in several steps of the process, including keyword extraction and studies selection. In our case, in order to calculate overlaps in the final study selection, authors calculated Krippendorff's alpha. More specifically, authors used the measure in the fourth stage of studies selection, the one that leaded to 28 studies from the previous set of 75 pre-selected studies. The inter-rater agreement test showed an agreement of 71.43% in the three groups of researchers (group 1: first author; group 2: second and third authors, group 3: fourth author). In this test, ideal values go around 80%, so, authors believe the agreement reached is acceptable.

D. DATA EXTRACTION

The first step in extracting information was to define the criteria for data inclusion. The criteria used for information inclusion (INFIC) are shown in Table 6.

TABLE 6. Information inclusion criteria (INFIC).

Criteria	Description
INFIC1	Identify existing frameworks for agile transformation and method adoption process.
INFIC2	Collect information on systematic/structural approach to agile transformation and method adoption process.
INFIC3	Identify explicitly stated criteria and factors for agile transformation process.
INFIC4	Collect potential groups and aspects influencing the agile transformation process such as obstacles, facilitators, tailoring criteria, stages and success factors.

In this research, four researchers performed data extraction. Primary studies were divided into two groups: agile transformation frameworks group and issues and situational factors group. Two authors individually revised each study from the agile transformation framework group, and the other two authors individually revised each study from the issues and situational factor set. After reviewing both groups, researchers discussed jointly the obtained results and reached consensus on the conducted analysis.

Data extraction and analysis from primary studies was performed in a structured way and all the steps and type of information to be extracted were defined prior to the initiation of the extraction process. The information extraction form used in this research is presented in Table 7. The general structure and the contents of this form was adjusted from one previous research [58] in order to meet the research objectives of this study.

TABLE 7. Information extraction form.

Study identification
- Unique identifier (code):
- Publication title:
- Author(s):
- Contact information:
- Journal/Conference (where the study was published):
- Date of publication:
- Country (where the study was published or presented):

Study methodology
- Type of study:
- Country (where the research was conducted or implemented):
- Objectives and motivation of pursuing an Agile adoption/transformation/transition:
- Identified frameworks for the Agile adoption/transformation/transition:
- Identified issues and aspects of agile transformation process:
- Identified situational factors of agile transformation process:

Study results/outcomes
- Derived comparison and classification of adoption frameworks elements and systematic approaches to transformation (strategy, characteristics, dependencies between practices):
- Derived classification and grouping of issues and aspects influencing the Agile transformation/transition/adoption:
- Identified classification of situational factors influencing the Agile transformation/transition/adoption:

Study problems
- Limitations:
- Deviation between expected and obtained results:

Results extraction
- Study outcomes:
- Study contribution:
- Other relevant issues:

In Table 8, the list of the 28 selected primary studies is presented. The first column shows the code of each primary study that will be used in the rest of this paper.

IV. RESULTS

In this section, results obtained are presented based on the proposed research questions and the aspects identified in the selected primary studies.

TABLE 8. List of primary studies.

Code	Title	Authors	Year
P1	A Framework for adapting agile development methodologies	Lan Cao, Kannan Mohan, Peng Xu, Balasubramaniam Ramesh	2009
P2	Overview and Guidance on Agile Development in Large organisations	Jordan B. Barlow, Justin Scott Giboney, Mark Jeffrey Keith, David W. Wilson, Ryan M. Schuetzler, Paul Benjamin Lowry, Anthony Vance	2011
P3	Acceptance of agile methodologies: A critical review and conceptual framework	Frank K.Y. Chan, James Y.L. Thong	2008
P4	Approaches to Agile Adoption in Large Settings - A comparison of the Results from a Literature Analysis and an Industrial Inventory	Anna Rohunen, Pilar Rodriguez, Pasi Kuvaja, Lech Krzanik, Jouni Markkula	2010
P5	A framework to support the evaluation, adoption and improvement of agile methods in practice	Asif Qumer, Brian Henderson-Sellers	2008
P6	An empirically-developed framework for Agile transition and adoption - A Grounded Theory approach	Taghi Javdani Gandomani, Mina Ziaei Nafchi	2015
P7	A disciplined approach to adopting agile practices: the agile adoption framework	Ahmed Sidky, James Arthur, Shawn Bohner	2007
P8	Situational Evaluation of Method Fragments: An Evidence-Based Goal-Oriented Approach	Hesam Chiniforooshan Esfahani, Eric Yu, Jordi Cabot	2010
P9	Method and Developer Characteristics for Effective Agile Method Tailoring - A Study of Expert Opinion	Kieran Conboy, Brian Fitzgerald	2010
P10	Customizing agile methods to software practices at Intel Shannon	Brian Fitzgerald, Gerard Hartnett, Kieran Conboy	2006
P11	A comparison of issues and advantages in agile and incremental development between state of the art and an industrial case	Kai Petersen, Claes Wohlin	2009
P12	Agile methods rapidly replacing traditional methods at Nokia - A survey of opinions on agile transformation	Maarit Laanti, Outi Salo, Pekka Abrahamsson	2011
P13	Post-agility: What follows a decade of agility?	Richard Baskerville, Jan Pries-Heje, Sabine Madsen	2011
P14	Strengths and barriers behind the successful agile deployment - insights from the tree software intensive companies in Finland	Minna Pikkarainen, Outi Salo, Raija Kuusela, Pekka Abrahamsson	2012
P15	Communities of practice in a large distributed agile software development organization - case Ericsson	Maria Paasivaara, Casper Lassenius	2014
P16	Artefacts and agile method tailoring in large-scale offshore software development programmes	Julian M. Bass	2016

TABLE 8. *(Continued.)* **List of primary studies.**

P17	Balancing Agility and Discipline: A Guide for the Perplexed	Barry Boehm, Richard Turner	2003
P18	Empirical studies of agile software development - A systematic review	Tore Dyba, Torgeir Dingsoyr	2008
P19	Identifying some important success factors in adopting agile software development practices	Subhas Chandra Misra, Vinod Kumar, Uma Kumar	2009
P20	Drivers of agile software development use: Dialectic interplay between benefits and hindrances	Leo Vijayasarathy, Dan Turk	2012
P21	The situational factors that affect the software development process: Towards a comprehensive reference framework	Paul Clarke, Rory O'Connor	2012
P22	Criteria for Software Process Tailoring: A Systematic Review	Georg Kalus, Marco Kuhrmann	2013
P23	Factors associated with the software development agility of successful projects	Jim Sheffield, Julien Lemetayer	2013
P24	Using metrics in Agile and Lean Software Development - A systematic literature review of industrial studies	Eetu Kupiainen, Mika Mantyla, Juha Itkonen	2015
P25	A systematic literature review on agile requirements engineering practice and challenges	Irum Inayat, Siti Salwah Salim, Sabrina Marczak, Maya Daneva, Shahaboddin Shamshirband	2015
P26	Exploring principles of user-cantered agile software development: A literature review	Manuel Brhel, Hendrik Meth, Alexander Maedche, Karl Werder	2015
P27	Agile methods tailoring - A systematic literature review	Amadeu Silveira Campanelli, Fernando Silva Parreiras	2015
P28	A systematic mapping study on the combination of software architecture and agile development	Cheng Yang, Peng Liang, Paris Avgeriou	2016

Section IV.A aims at responding RQ1: *Which frameworks for agile transition and adoption exist in the literature?* This section presents the identified structured approaches and frameworks for agile transformation process.

Sections IV.B, IV.C, IV.D and IV.E aim at responding RQ2: *Which issues and aspects are discussed in agile transition and adoption literature and how can they be grouped and organized?* Firstly, section IV.B presents activities that may be conducted before the initiation of agile transition and adoption process. Secondly, section IV.C describes obstacles and results of agile transition and adoption process. Thirdly, section IV.D details stages and activities for agile transition and adoption process. Finally, section IV.E identifies agile practices used in agile transition and adoption processes.

RQ3: *Which are the situational factors affecting agile transition and adoption process?* is answered in section IV.F. These situational factors are organized in a logical manner and presented in different sub-sections: method selection factors (IV.F.1), agile transition support and success factors (IV.F.2), agile software development processes (IV.F.3), software development processes criteria and factors (IV.F.4) and agile method tailoring factors (IV.F.5).

A. AGILE TRANSFORMATION FRAMEWORKS

During the analysis of the selected primary studies, nine agile transformation frameworks and structural approaches for agile transformation and agile method adoption process were identified. The primary studies P1-P9 (following the coding in Table 8) present these frameworks and structural approaches. In this section, each framework is presented. Later, in the discussion section, all the presented frameworks are analyzed and systematically compared.

(P1) Cao *et al.* [7] proposed a framework for adapting agile development methodologies. They conducted a multisite case study, and investigated how the structure of agile methods, projects, and organizations affects the agile method adoption process. The proposed framework in their research presents a description for adapting agile development methodologies. According to the authors of the study, agile adoption process is considered as the process of involving adding, dropping, or modifying specific practices prescribed by specific agile methods. The challenges addressed by the practices that are implemented in organizations are classified in challenge groups. The framework highlights that agile practices are customized depending on the specific context of the project, organization and development process.

(P2) Barlow *et al.* [42] proposed a framework presenting guidelines for large organizations with recommendations on how process change should be managed in large organizations to successfully implement agile practices. The framework suggests an adequate methodology to be used depending on the identified organizational needs. Three main factors influencing the choice of adequate methodology were identified in this research: (1) volatility level of the project team - turnover rate, (2) project interdependencies - from sequential to reciprocal, and (3) project team size - varying from small to large. Based on the project environment, one of the three methodologies may be chosen to implement projects in large IT companies: plan driven, agile or hybrid.

(P3) Chan and Thong [43] presented a conceptual framework for accepting agile methods in organizations. Knowledge management perspective is an essential part of the framework, due to the intensive interaction of the developers and customers. Factors influencing the acceptance of agile methodology are organized in four groupings: (1) ability-related factors, (2) motivation-related factors, (3) opportunity-related factors and (4) agile methodology characteristics. The ability, motivation and opportunity related factor groupings (1, 2, 3) are influencing the fifth grouping (5) the knowledge management outcomes, which is also related to the acceptance of agile methods. This conceptual framework helps organizations to consider multiple

perspectives in deploying agile methodologies among system developers.

(P4) Rohunen *et al.* [44] performed a literature analysis of agile adoption strategies. The obtained results are synthesized in three categories: (1) strategy types in adoption of agile methods, (2) stages of agile adoption, and (3) managing dependencies between different agile method adoptions. The first result of this literature review was the identification of agile adoption strategies: wholesale vs. incremental, bottom-up vs. top-down. In wholesale strategies, the agile method would be adopted at once in the company, while in the incremental approaches gradual adoption of practices would be pursued. The second result of the work was the identification of three typical elements of the agile method adoption initiatives in organizations: (1) an agility measurement model used to guide and assist the adoption process, (2) adoption frameworks consisting of different stages, and (3) intention to manage the dependencies between different agile practices during the transformation process.

(P5) Qumer and Henderson-Sellers [3] introduced a complete framework to assist managers in evaluating the required degree of agility in the company, and to assist them on appropriating the way of introducing agility. They developed an analytical framework measuring the degree of agility, called 4-DAT, which was applied to six agile methods and to two traditional methods [59]. The 4-DAT model together with the Agile Toolkit are the major elements of the Agile Software Solution Framework (ASSF) which provides a guidance for self-organized and empowered agile teams in large and complex project development environments. 4-DAT and Agile toolkit provide useful information about agility characteristics of process elements, however, none of them support the agile adoption process. Agile adoption and improvement model (AAIM) was developed based on industry analysis by means of Grounded Theory method [3]. AAIM is a method-independent model developed for software development organizations to adopt and improve agile practices for a specific situation or project. It consists of three agile blocks (Prompt, Crux and Apex) and six agile stages - agile practices used in each agile block (infancy, initial, realization, value, smart and progress).

(P6) Gandomani and Nafchi [20] conducted a grounded theory research and, as a result, obtained an empirically-developed framework for agile transition and adoption. The results of their research present different aspects of agile transition and adoption process: agile transition facilitators, transition challenges and issues, key prerequisites of agile transformation and an agile transition and adoption framework. Structural characteristics and key activities are two fundamental aspects of this agile transition and adoption framework. The identified structural characteristics are: value-based, iterative, continuous and gradual. The key activities of the framework are: practice selection, adaptation, assessment, retrospective and adjustment.

(P7) Sidky *et al.* [45] presented an agile adoption framework to guide and assist the agile adoption efforts of organizations. The framework consists of two modules: an agile measurement index and a four-stage process for the agile transition and adoption process. The first component of the framework, the Sidky Agile Measurement Index (SAMI), is composed of four modules: agile levels – five levels of agile practices making significant improvements in the software development process (collaborative, evolutionary, effective, adaptive and encompassing), agile principles – guidelines to be employed to ensure that development process is agile, agile practices and concepts – activities and techniques used to develop and manage software project aligned with agile principles, and indicators – questions to be used to assess the readiness of the organization or project to adopt an agile practice. The second component of the framework is the four-stage process for agile adoption. The first and second components are interrelated, and depending on the result of the SAMI, the four-stage process for agile adoption is guided. The first stage is named Discontinuing factors. At this stage, go or no-go decision to adopt agile practices is made, and potential discontinuing factors influencing the agile adoption process are identified and removed, if possible. Second, third and fourth stage provide guidelines for identifying the agile practices suitable for a single project. The second stage – Project level and assessment, identifies the agility level that a project could reach. The third stage – Organizational readiness assessment, identifies to which extent the company is ready to accommodate the project's target level of agility. Finally, the fourth stage – Reconciliation, identifies the gap between agility project level and organizational agility level readiness (second and third stages), and the needed agile practices are recommended by tool.

(P8) Framework for evaluating the suitability of candidate method fragments prior to adoption in software projects is derived in the research study [60]. The proposed framework presents evidence-based repositories derived as a result of a systematic literature review of empirical studies. Depending on the objectives of the transformation, employees should choose which agile method practice to implement. Evidence base consists of two repositories: method fragment repository and model fragment repository. Furthermore, method fragment repository is divided into objectives dataset and requisites dataset. Process designer should retrieve agile model fragments, merge and customize the selected fragments and evaluate the integrated model.

(P9) Conboy and Fitzgerald [47] proposed a framework based on an extensive literature review and interviews conducted with 20 senior software development researchers. The specific objectives of their research were to assess the tailoring adequacy of XP, to provide a set of recommendations, to investigate how developers are undertaking XP tailoring initiatives, and to provide a set of best practices to be followed by the developers. It was identified that ''silver bullet'' approach towards method tailoring is somewhat misguiding. Project is a unique endeavor and the choice of the method should be guided by the organizational, technical or human factors affecting the system being developed.

The framework consists of two sets of factors – method characteristics and developer practices, which together influence the effectiveness of method tailoring. Four method characteristics were identified in the research: (1) explicit statement of method boundaries, (2) contingency built in the method to guide tailoring, (3) clear description of method and method practices, and (4) independence of individual method practices – meaning that success is not dependent on the application of multiple practices. Three developer practices were identified as follows: (1) identification of the project context dependencies, (2) familiarity with portfolio of methods and method fragments, and (3) disciplined and purposeful approach to method tailoring. In this research, recommendations for researchers and practitioners on how to improve XP tailoring were derived. Recommendations for software engineering researchers were formulated to further investigate the following topics: explicit statement of the method boundaries, contingencies built in the method itself to guide tailoring, clear description of the method rationale behind method practices and on the independence of individual method practices. For practitioners, the following recommendations were derived: to identify project context dependencies, to get familiar with the range of methods and method fragments, and to have disciplined and purposeful approach to method tailoring.

B. PRE-TRANSFORMATION ACTIVITIES

Pre-transformation activities should be conducted before initiating the agile transition process in the organization. These activities support the identification of discontinuing factors, the assessment of current agility level in the company, and the selection of the transformation strategy type to be pursued in the agile transformation process. Five primary studies discussing pre-transformation activities were identified. Three discussion topics were identified: agility assessment, go-no go decision and agile tailoring strategy. These discussion topics and primary studies are presented in Table 9.

TABLE 9. Pre-transformation activities.

Topic	Pre-transformation activities	Primary study
1. Agility assessment	4-DAT	P5
	SAMI	P7
2. Go-no go decision	Discontinuing factors	P7
3. Agile tailoring strategy	Wholesale vs. incremental, and bottom-up vs. top-down	P4
	Contingency approach vs. method engineering approach	P10
	Seven agile adoption strategies and experience reports	P18

Discussion topics related to the pre-transformation activities identified in the primary studies are presented in what follows:

1. Agility assessment: Two primary studies propose a tool for evaluating the degree of agility in the company: *4-DAT* and *SAMI*. Both tools are an integral part of the framework and they can be used for evaluating agility level in the company.

- (P5) 4-DAT framework was proposed in the research of Qumer and Henderson-Sellers [3] where they introduced a complete framework to assist managers in evaluating the needed degree of agility in the company and to assist them on appropriating the way of introducing agility.
- (P7) SAMI (The Sidky Agile Measurement Index) is one of the two components of an agile adoption framework [45] used to guide and to assist the agile adoption efforts of organizations. SAMI is composed of four components: agile levels, agile principles, agile practices and concepts and indicators.

2. Go-no go decision: (P7)*Discontinuing factors* is the first stage in the 4-stage agile adoption process proposed in Sidky's adoption framework [45]. This first stage assists in deriving go or no-go decision - whether to adopt agile practices or not. Moreover, it helps to identify and remove potential discontinuing factors influencing (blocking) the agile adoption process. The second, third and fourth stage in this framework provide guidelines for identifying the agile practices suitable for each specific project.

3. Agile tailoring strategy: Three primary studies discuss on agile tailoring strategies.

- (P4) Rohunen *et al.* [44] performed a literature analysis of agile adoption strategies. Identified strategies in the literature: wholesale, incremental, bottom-up and top-down. In case of wholesale strategies, the agile method would be adopted at once in the company. With the incremental approach, a gradual adoption of practices would be pursued. Bottom-up and top-down approaches bring a different perspective on the initiative of the transformation. If the decision is made in the top level management to pursue the agile transformation, then a top-down approach is used. If a change process is initiated from the lower levels of the organization structures, then a bottom-up approach is employed.
- (P10) Fitzgerald *et al.* [13] conducted a research study of agile methods tailoring, XP and Scrum, at Intel Shannon. Their literature review concluded that research in method tailoring can be divided into two streams: (1) contingency factor approach – where specific features of the development context are mapped to the selection of an appropriate development method, from the variety of available methods, based on the contingencies of the current situation; (2) method engineering approach – respecting the development methods but recognizing the necessity of flexibility of tuning the method to the specific project needs. In this manner, if the organization would use the contingency factor approach, as a pre-transformation activity - development context would be evaluated, and best fitting method from the available methods would be selected.
- (P18) Dyba and Dingsoyr [5] performed a systematic review of empirical studies in agile software development. Seven primary studies on the introduction and

adoption of agile development methods were identified. Research studies provided experience reports and strategic approaches towards the agile adoption process. The aims of the primary studies were as follows: understanding the differences between XP and waterfall and to examine impact of knowledge creation on the adoption of XP; to study why and how XP is adopted and used in day to day software production; to study the integration of agile teams into stage-gate software development, test the applicability of lean techniques in software development; to study how agile processes affect collaboration in organizations; to study the introduction of a process based XP in software development environment and, finally, to understand how newcomers practice XP and how are these practices improved over time in organizations.

C. OBSTACLES AND RESULTS OF THE AGILE TRANSITION AND ADOPTION PROCESS

Different aspects of an agile transformation process such as challenges, barriers, benefits and results were discussed in six primary studies. The identified classification of obstacles and results, and the specific issues in each classification are presented in Table 10.

The agile transformation obstacles and benefits identified in the primary studies are discussed in what follows:

- (P1) The main challenges in the adoption of agile methods are grouped in the following categories of software development outcomes: development process-related challenges, customer-related challenges, developer-related challenges and organization/management related challenges [7].
- (P6) As a result of the study, one of the aspects of the agile transition and adoption process was related to transition challenges and issues, specifically to: negative human aspects, inadequate and dysfunctional training, customer issues and technical issues [20].
- (P11) The work is aimed to identify advantages and challenges in an industrial large-scale set-up. As a result, authors presented a literature overview of 11 advantages and 10 issues in incremental agile development [15].
- (P12) This work conducted by Laanti *et al.* [16] aimed at discovering the impact of an agile transformation in a very large software development environment. The study was conducted in Nokia Company. Data was collected using a questionnaire, collecting answers from 1000 respondents coming from seven different countries. Besides parametric research and clustering analysis, the qualitatively data obtained in the study was analyzed with the aim of collecting the opinion of respondents on main challenges and benefits of agile method implementation in their company. A list of 17 challenges and benefits was presented as a result. The list of challenges was further analyzed and top three perceived challenges of agile development (with a positive perceived influence or a negatively perceived influence) are identified, and similarly top three perceived benefits of the agile development (with a positive perceived influence and a negatively perceived influence) are presented. Top challenges and benefits are presented in Table 10, in the general issues and challenges classification.

TABLE 10. Obstacles and results of the agile transformation process.

Issue classification	Specific issues	Primary study
Development process related issues	Abstraction in architectural design, forward refactoring, design by formalized agreement, minimal traceability, post hoc documentation, minimal documentation	P1
Customer related issues	Shared understanding of specification, agreement on quality	
Developer related issues	Pairing for overlaps, empowerment through shared expertise	
Management and organization related issues	Upfront estimation, balanced formality	
General issues and challenges	Negative human aspects, inadequate and dysfunctional training, technical related	P6
	Deployment of agile methods, requirement management/iterative planning, dependencies, co-operation, work distribution, subcontracting and resourcing/effort management	P12
	High effort for continuous testing, lack of architectural design/scaling issues, pair programing exhaustive and inefficient, team members need to be highly qualified, between team communication decrease, fear of managers towards engineering empowerment, implementations starts too early for managers, pair programing for unequal partners, on site customer devotion to dev. process	P11
	Challenging technical environment, continuous estimation and planning, continuous requirements management, continuous project monitoring, continuous testing, domain knowledge, understanding roles and responsibilities, more lightweight documentation, version control, agile architecture	P14
	Minimal documentation, customer availability, inappropriate architecture, budget and time estimation, neglecting non-functional requirements, customer inability and agreement, contractual limitations, requirements change and its evaluation	P25
General benefits and results	Visibility and transparency, requirements management, productivity, frequent delivery	P12
	Better knowledge transfer, customer perceived valuable/early feedback, improved learning, productivity and code quality in pair programing, increased motivation (XP is technical), better insight in development process, improved social job environment, customer involvement, visibility and transparency, iterative planning	P11
	Better understanding of customer demands, communication and collaboration, learning, improvement techniques, self-organizing teams, UI process	P14

- (P14) Pikkarainen *et al.* [17] performed three in-depth case studies in different software intensive companies in Finland which involved 57 interviewees in total. The objective of the research was to contribute to deeper understanding of relatively under researched phenomena of the agile deployment and software process improvement. As a result, 71 strengths and 169 barriers to agile deployment were identified. As a summary, 16 strengths and barriers identified in multiple case studies are presented in Table 10, in the issue classification "General issues and challenges".
- (P25) Inayat *et al.* [18] conducted a systematic literature review aiming to discover the agile requirements engineering practices and potential challenges in practice deployment. The main objective of this paper was to develop an understanding of requirement engineering practices in agile methods as well as to identify challenges encountered by teams in requirements engineering contexts. Additionally, results provided an overview of specific agile requirements engineering practices that could tackle known challenges of traditional requirements engineering approaches. As a summary, 8 challenges to requirements engineering are presented in Table 10, in the issue classification "General issues and challenges".

D. STAGES AND ACTIVITIES IN THE AGILE TRANSITION AND ADOPTION PROCESS

Reported activities to be implemented and the sequential stages expected during the transformation process are presented in this section. Different approaches regarding the division of the agile deployment stages may be found in primary studies. Some of the studies, beyond defining the exact levels and stages in the agile transformation process, also present various activities or practices typical for each agile level. The summary of the identified stages and activities in the agile transformation process are presented in Table 11.

A short description of the primary studies related to the agile deployment stages and activities are presented in the following paragraphs:

- (P7) The agile adoption framework proposed by [45] consists of two components: an agile measurement index (SAMI) and a four-stage process. The first component of the SAMI tool defines five levels of agile practices making significant improvements in the software development process. *Collaborative* is the first level of agility fostering communication and collaboration between all stakeholders, *Evolutionary* is the second level of early and continuous delivery of software, *Effective* is the third level which focus is to increase efficiency of development process through adoption of engineering practices, *Adaptive* is the fourth level focusing on responding to change in the process and *Encompassing* is the fifth level that concentrates on establishing the environment to foster agility throughout the organization.

TABLE 11. Agile deployment stages and activities and practices.

Level / stage	Description			Primary study
Level 1	Collaborative			
Level 2	Evolutionary			
Level 3	Effective			P7
Level 4	Adaptive			
Level 5	Encompassing			
Phase 1	Transformation			
Phase 2	Scaling			P15
Phase 3	Continuous improvement			
			Main Practices	
Level 1	Agile block Prompt		Agile infancy	
Level 2	Agile block Crux		Agile initial Agile realization	P5
Level 3	Agile block Apex		Agile value Agile smart Agile progress	
			Main Activities	
Level 1	Preliminary activities (P4)	1. Select Agile practice (P6, P14)	A. Set goals for deployment (P14) B. Identify suitable agile practices (P14) C. Select and prioritize the agile practices to deploy (P14)	
		2. Plan the deployment / adaptation of the method (P6, P14)	A. Plan the deployment (P14) B. Prepare the deployment (P14)	
Level 2	Implementation activities (P4)	1. Execute the deployment / assessment (P6, P14)	A. Execute the deployment (P14) B. Iteratively improve, validate and package feedback in projects (P14)	P4, P6, P14
		2. Analyze, improve and package / Retrospective and adjustment (P6, P14)	A. Analyze project practices, problems and recommendations, based on project feedback (P14) B. Improve the organizational processes (P14) C. Package (P14)	

- (P15) Defined research objective of the paper was the exploration of the role of communities of practice in the agile transformation. Authors identified that the role of the community of practice has changed depending on the agile transformation phases. It started as a (1) support mechanism for the agile transformation, then it became (2) support for scaling-up, and finally established its role as a forum for (3) continuous improvement. Main practical implications for the practitioners were that

communities of practice can support lean and agile transformation in the organization [61].

- (P5) Qumer and Henderson-Sellers [3] introduced a complete framework to assist managers in evaluating the required degree of agility in the company and to assist them on appropriating the way of introducing agility. The Agile Adoption and Improvement Model (AAIM) was developed based on industry analysis. AAIM is a method-independent model developed for software development organizations to adopt and improve agile practices for a specific situation or project. It consists of three agile blocks (*Prompt*, *Crux* and *Apex*) and six agile stages – agile practices used in each agile block level (*infancy*, *initial*, *realization*, *value*, *smart* and *progress*). The agile blocks are ordered from basic to advanced and, by means of 4-DAT, the current agility level may be measured in each block. The agile stages are embedded in three agile blocks. Stage one is included in block one (Prompt), stages two three and four are included in block 2 (Crux) and stage five and six are included in third block (Apex).
- (P4) Rohunen *et al.* [44] performed a literature analysis of agile adoption strategies. The results of this analysis were synthesized in three categories: (1) the types in the adoption of agile methods, (2) the stages of agile adoption (*preliminary* and *implementation activities*), and (3) the management of dependencies between different agile method adoptions.
- (P6) Gandomani and Nafchi [20] conducted a grounded theory research and, as a result, presented an empirically-developed framework for agile transition and adoption. Their results leaded to different aspects of the agile transition and adoption process. According to these authors, key activities of the agile transition framework are: *practice selection*, *adaptation*, *assessment*, and *retrospective and adjustment*.
- (P14) Pikkarainen *et al.* [17] performed three in-depth case studies in different software intensive companies in Finland which involved 57 interviewees in total. They presented four agile deployment steps and the main activities to be performed in the agile deployment.

In Table 11, deployment stages, and activities and practices are presented, but one more primary study presenting agile deployment activities, regardless of deployment stages, is not embedded in this table since results are not related to agile deployment stages. In [67], authors presented diverse classifications of the activities to be conducted in the agile process tailoring initiatives, but the exact stages or levels of the agile transformation were not specified. In their research, they performed a systematic review of literature with the aim of proposing criteria for software processes tailoring. It is commonly accepted that any software process needs to be tailored to the particular project environment, as it becomes otherwise, a project risk. The objective of the research was to identify the set of characteristics of a project that shall be considered for tailoring software processes. No common guideline was available to support the selection of concrete agile practices. Moreover, in the majority of current research, systematization and generalization are missing. Appropriate measures (20 actions) in software process tailoring were grouped in four classifications as follows:

- Stakeholder-related actions (4): intensify customer involvement, intensify end user involvement, ensure management involvement, and intensify end user trainings.
- Project lifecycle actions (7): put emphasis on system architecture, put emphasis on integration and test, put emphasis on financial project management, put emphasis on prototype development, put emphasis on continuous delivery and deployment, and put emphasis on planning pattern for time critical development.
- Project organization actions (6): expand project documentation (templates), reduce documentation - daily for feedback, increase number of micro iterations, formalize project communication pattern, foster open project communication, and select appropriate tools.
- Knowledge building/preservation actions (3): intensify meetings/workshops, provide trainings, and provide knowledge management infrastructure.

E. AGILE PRACTICES USED IN THE AGILE TRANSITION AND ADOPTION PROCESS

The agile practices to be used in the agile transition and adoption process are discussed in six primary studies:

- (P1) Cao *et al.* [7] proposed a framework for adapting agile development methodologies. They investigated how the structure of the agile methods, the project, and the organization affect the agile method adoption process. The framework presents a description for adapting agile development methodologies. Furthermore, a concrete set of practices addressing challenges typical for adapting agile development methods are presented in the paper.
- (P7) The first component of the SAMI Framework is composed of four components: agile levels, agile principles, agile practices, and concepts and indicators [45]. Based on the agility level identified in the organization and on the project, the framework proposes a set of agile practices to be used, based on five main agile principles (embrace change to deliver customer value, plan and deliver software frequently, human centric, technical excellence and customer collaboration).
- (P8) Esfahani *et al.* [60] proposed a framework for evaluating the suitability of candidate methods prior to their adoption in software projects. They derived an evidence-based repository from a systematic literature review, and evaluated how agile practices influence on major and minor organizational requisites and objectives.
- (P10) The key contribution of the research was the detailed description of how XP and Scrum methods were tailored and combined in the company.

Specific practices chosen from each agile method (XP and Scrum) were demonstrated [13].

- (P25) Inayat *et al.* [18] conducted a systematic literature review with the aim of discovering the agile requirements engineering practices and challenges. The performed research study presents a focused perspective on requirements engineering processes, regardless of the agile method employed in the organization. Results provide an overview of which agile requirement engineering practices could resolve the challenges of traditional requirements engineering approaches. In that respect, in Table 12, 14 agile practices are suggested as a solution to the typical challenges of agile adoption process.
- (P28) Yang *et al.* [62] performed a systematic literature review with the aim of exploring the integration of software architecture and agile development. This research presents another example of focused perspective on architecting process, regardless of agile method employed in the organization. 43 architecture strategies and 20 top agile practices (out of 41 identified) related to product architecture are presented in Table 12.

The agile practices presented in Table 12 are the most used practices in the analyzed primary studies. The list of *Top 20 practices* identified by (P28) [62] was used to present the results in Table 12. The identified practices in the primary studies are presented in the order of the Top 20 list. Additional practices that are not in this list are presented in the *Other practices* group.

TABLE 12. Most used agile practices in the agile transformation process.

Group	Practice	Primary study					
		P1	P7	P8	P10	P25	P28
Top 20 practices	Test driven development		X				X
	Pair programming	X	X	X	X		X
	Continuous integration		X				X
	Daily standup/progress meetings		X	X			X
	Refactoring				X		X
	On site customer	X		X			X
	Backlog		X				X
	Collective code ownership	X			X		X
	Retrospective		X		X	X	X
	Coding standard		X		x		X
	User story/metaphor		X		X	X	X
	Planning game/collaborative planning	X	x		X		X
	Iteration/continuous/adaptive planning		X		X	X	X
	Iterative/evolutionary development/requirements		X		X	X	X
	Open work area						X
	Simple design	X			X		X
	Unit testing		X		X		X
	Iteration review				X	X	X
	System metaphor/architecture				X		X
	Short and frequent release		X		X		X
Other practices	Agile/just enough documentation	X	X				
	Plan features not tasks		X				
	Task volunteering		X				
	Continuous delivery		X				
	Face to face communication		X			X	
	Customer/client involvement		X			X	
	Requirement prioritization					X	
	Change management					X	
	Cross-functional teams					X	
	Prototyping					X	
	Testing before coding					X	
	Requirements modeling					X	
	Requirements management					X	
	Review meetings and acceptance tests					X	
	Code refactoring/continuous improvement	X	X			X	
	Shared conceptualization					X	
	Pairing for requirements analysis					X	
	Open office space			X			
	Time boxing			X	X		

F. SITUATIONAL FACTORS

This section presents a summary of the situational factors identified in the primary studies that affect the general agile transition and adoption process. In this research, situational factors are identified in different domains and they represent the situational context influencing the agile transition and adoption process. The situational factors identified in the primary studies are presented in six sub-sections, and they are logically grouped in order to demonstrate which aspect of the agile transition process is discussed in the reviewed literature. These factors are divided into different groupings and they present main elements affecting the agile transformation process in the organization. The list of identified factors presented in Table 20 provides support for industry and practitioners who are challenged with the creation of a strategy and will pursue the implementation of the agile transformation process in the organization.

This section presents the general strategies and approaches to agile method tailoring based on the situational factors in the organization and project. In Section IV.F.1, method selection factors are discussed - situational factors based on which choice of the appropriate method usage can be made (agile/hybrid/plan driven). In Section IV.F.2, specific agile transition support and success factors are demonstrated. Situational factors affecting the agile software development are summarized in Section IV.F.3. Situational factors affecting the software development processes are shown in Section IV.F.4. In the last section, Section IV.F.5, agile method tailoring factors are presented.

Two streams of research may be found in the literature on agile method adoption strategies: contingency factor approach and method engineering approach [13]. On the one hand, an organization could pursue the contingency factor

approach, and based on the contingency factors identified in the current context of project and organization, before the initiation of the agile transformation process, the most adequate method for the organization and project can be selected. On the other hand, if method engineering approach is pursued, the available agile methods are "engineered" and customized to fit the specific needs of the organization and the current project. Having employed any of the previously mentioned agile adoption strategies, the situational factors affecting the agile transition and adoption process may be used, either as contingency factors, in the contingency factor approach, or as situational factors acting as inputs for the method engineering approach. If the contingency factor approach is employed as the agile adoption strategy in the organization, the situational factors presented in Section IV.F.1 may be used to determine the adequate method depending on the situational (contingency) factors of the organization and/or project. If the agile method engineering approach is employed as the agile adoption strategy in the organization, tailoring approach may be pursued based on the situational factors presented in Sections IV.F.2, IV.F.3, IV.F.4 and IV.F.5.

Apart from agile adoption strategies based on situational factors, three primary studies discuss tailoring strategies and approaches. A successful method engineering approach for XP and Scrum was presented in the research study conducted in Intel Shannon [13]. Another primary study presented a combination of agile and plan driven approaches, and referred to this as a post-agility example [63]. The tailoring strategy can also be based on different method tailoring criteria based on the characteristics of the method itself, and on the characteristics of the developers involved in the tailoring process [47].

1) METHOD SELECTION FACTORS

Two primary research studies address the aspect of selecting the appropriate methodology based on specific factors in the project. Three methodologies can be selected as appropriate for a particular project: agile, plan driven or hybrid.

- (P17) Boehm and Turner [10] derived five critical factors influencing the suitability of plan driven or agile methods in a specific project situation. If factor measurement does not show clearly which method should be employed, these authors suggest a hybrid approach with well-established risk management mechanisms to proactively control the potential problems in project management. The factors used to identify the project situation are: *size*, *criticality*, *dynamism*, *personnel* and *culture*.
- (P2) Barlow *et al.* [42] proposed a framework with guidelines and suggestions for large organizations referring to how processes should be established to successfully implement agile practices. The proposed framework aims to explain theoretically the greater or smaller suitability of the agile techniques for specific types of environments. The framework proposes the selection of an adequate methodology to be used depending on the organization needs (agile, plan driven or hybrid). Three main factors influencing the framework scenario (decision making process of which method should be used) were identified: *volatility level of the project team* (turnover rate), *project interdependencies* (sequential to reciprocal), and *project team size* (small to large).

2) AGILE TRANSITION SUPPORT AND SUCCESS FACTORS

This section presents the situational factors facilitating and supporting the transition and positively affecting the acceptance of agile methods. Besides identifying the factors with positive influence on the process of the agile transition, it is important to assess the effect of the transition process. In that regard, factors related to the agile transformation success, factors indicative of success in agile projects and factors influencing the success of user/client integration in the agile processes are also included in this section. Usually, the studies investigating the factors with positive effect on the agile transition process (support) also refer to the results of the agile deployment process (success), so these two classifications are closely linked and presented together in the same section.

Three primary studies present conceptual frameworks and factors supporting the agile transformation process. Identified situational factors and their classification are presented in Table 13.

TABLE 13. Transition supporting factors.

Factor classification	Factors	Primary study
General facilitators	Training, management buy-in, team members buy-in, good coaching and mentoring, right people selection and empowering teams, continuous meetings and negotiations, agile champions, incentive factors	P6
	Communities of practice existence	P15
Ability related	SDM self-efficacy, experience, training, external support	
Motivation related	Career consequences, top management support, voluntariness, subjective norm, organizational culture	
Opportunity related	Teamwork, communication, shared understanding, arduous relationship	P3
Agile methodology characteristics	Perceived usefulness, perceived ease of use, perceived compatibility, result demonstrability, perceived maturity	
Knowledge management outcomes	Knowledge creation, knowledge retention, knowledge transfer	

A short summary of transition supporting factors identified in the primary studies is presented in what follows:

- (P6) The results of [20] presented three groups of factors affecting the agile transition and adoption process: (1) agile transition facilitators, (2) transition challenges and issues and (3) key prerequisites of agile transformation. The set of Agile transition facilitators is presented in Table 13.

- (P15) Research objective of [61] was to explore the role of communities of practice in the agile transformation. Different examples of the communities of practice existing in the case company were presented. In this organization, communities of practice were initially used to support agile transformation process and, later on, they supported continuous improvements in the organization.
- (P3) Chan and Thong [43] presented the conceptual framework for accepting agile methods in organizations. The factors influencing the acceptance of the agile methodology are organized in five groupings: *ability-related* factors, *motivation-related* factors, *opportunity-related* factors, *agile methodology characteristics*, and *knowledge management outcomes*.

Identified transition success factors in primary studies are presented in Table 14.

TABLE 14. Transition success factors.

Factor classification	Factors	Source
Project environment	Compliance and governance factors, culture (entrepreneurship vs. risk awareness), instability of org. environment, nature of the contract, power distance, national culture, top management support for one approach, training	P23
Project	Co-location of team members, customer collaboration commitment and involvement, experience level, personnel skills and team maturity, procedural empowerment of the project team, project cost, project criticality, project duration, project size (man hours), requirements uncertainty/stability, proportion of the organization affected, team size, technological uncertainty, urgency	
Integration	Process integration, practices integration, people integration, social integration, technology integration	P26
Transition success factors	Separate product discovery and product creation, iterative and incremental design and development, parallel interwoven creation tracks, continuous stakeholder involvement and artifact-mediated communication	P14

A short summary of transition success factors identified in primary studies is presented in the continuation:

- (P23) Sheffield and Lemétayer [64] conducted an empirical study of successful projects aiming to investigate which factors in the project and its environment, are indicative of software development agility in successful projects. From the research literature, different groups of factors were extracted: 7 factors were extracted to describe *project environment*, 13 factors to describe *project*, 5 factors to describe *software development agility* and 8 factors to describe *project success*. In Table 14, 20 factors in the project and project environment are presented, while software development agility was not presented since it shows relation to agile postulates and criteria for project success is not directly related to agile transition and adoption process success.
- (P26) Brhel *et al.* [11] conducted a systematic literature review with the aim of deriving the generic principles on User-Centered Agile Software Development (UCASD). In this work, 83 publications were selected as primary sources of the research and results were divided into four dimensions: process, practices, people, social and technology. Five types of integration for UCASD were identified: process integration, practices integration, people integration, social integration and technology integration.
- (P14) Pikkarainen *et al.* [17] performed three in-depth case studies in different software intensive companies in Finland, which involved 57 interviewees in total. Four main implications and factors related to transformation success were derived: (1) management commitment and continuous support for agile deployment, (2) management clear vision, awareness and understanding of agile methods, (3) freedom to the teams to tailor agile methods towards their specific needs, and (4) continuous tailoring of agile based process model at the organizational level besides team level.

3) AGILE SOFTWARE DEVELOPMENT FACTORS

This section presents the situational factors influencing the agile software development processes. Three primary studies discuss specific important aspects for agile software development. The identified factors and their classification are presented in Table 15. The agile software development factors identified in each primary source are presented in the continuation of the section:

- (P18) The results of the systematic review of empirical studies of agile software development by Dyba and Dingsoyr [5] were grouped into four categories. Two of the categories are related to agile software development factors: (1) human social factors and (2) perceptions on agile methods. There are three human social factors affecting the agile software development: organizational culture, collaborative work and team characteristics. In addition, perception of customer, developer and student should be considered as agile software development factors.
- (P19) 14 factors divided into two classifications (people and organization) affecting the success of projects using agile software development practices are presented in [65]: competency, personal characteristics, communication and negotiation, societal culture, training & learning - belonging to people factors, and customer satisfaction, customer collaboration, customer commitment, decision time, team distribution, team size, corporate culture, planning and control - belonging to organization factors. They conducted a large-scale empirical study with 241 returned survey questionnaires. The objective of the study was to improve the

TABLE 15. Agile software development factors.

Factor classification	Factors	Primary study
Perception on agile methods	Organizational culture ,collaborative work, team characteristics, customer perceptions, developer perceptions, student perceptions	P18
People factors	Personal characteristics, societal culture, training & learning	
Organizational factors	Customer satisfaction, customer collaboration, customer commitment, corporate culture, control	P19
Project	Size, time, governance, criticality, rate of change, development cost, goals confliction – Stakeholder expectations	
Roles	Team (distribution, scale, experience), architect (role, responsibility, background and experience), customer (requirements, participation and collaboration), developer (attitude and behavior)	
People related	Communication, coordination/collaboration, learning, support from stakeholders, expertise	P28
Organization	Business, organization culture, technical environment, organization maturity	
System	System quality – complexity and safety, legacy system	
Architecture	Domain expert, architectural quality, architectural scope, architecting value and cost, architectural defects, architectural increment	

understanding of the emerging approach of agile software development, specifically factors influencing the success of projects that adopt agile software development practices. Linear multiple regression and correlation analysis were used to evaluate the significance (influence) of each factor on project success, and 8 were evaluated as significant for agile software development project success.

- (P28) The systematic literature review in [62] presented six factor classifications influencing the combination of software architecture and agility. The aim of the study was to explore the integration of software architecture and agile development. Various results were identified and classified in the study with regard to combining architecture and agile methods: architecting activities and approaches, agile practices, challenges, factors, tools, costs, benefits and lessons learned. Factors of architecture and agility combination were grouped into six categories: project, roles, architecture, people-related, organization and system.

4) SOFTWARE DEVELOPMENT PROCESS FACTORS AND CRITERIA

Previous Section IV.F.3 was focused on agile software development while, in this section, the research on general software development processes (not only agile) is presented. In the following Section IV.F.5, customization of general software development criteria for agile method adoption process is presented.

Two primary studies present situational factors and criteria affecting the general software development processes. The software development situational factors, criteria and their classification from primary studies are summarized in Table 16.

TABLE 16. Software development situational factors and criteria.

Factor/criteria classification	Factors/criteria	Primary study
Personnel	Turnover, team size, culture, experience, cohesion, skill, productivity (team and general), commitment, disharmony (interpersonal conflicts), changeability (scope creep and system requirements)	
Requirements	Feasibility, standard, rigidity, degree of risk	
Application	Performance, complexity, type, application size, predictability, connectivity, reuse, development phase, deployment profile, quality	P21
Technology	Knowledge, emergent	
Organization	Maturity, management commitment, stability, structure, facilities, organization size	
Operation	End-users, prerequisites	
Management	Expertise, accomplishment, continuity	
Business	External dependencies, business drivers, time to market, customer satisfaction, payment arrangements, project opportunities, magnitude of potential lose	
Team	Size, distribution, turnover, previous cooperation, good cooperation, domain knowledge, tool knowledge, technology knowledge, process knowledge	
Internal environment	Prototyping, clear project proposal, management availability, management support, project budget, project duration, project type, project role in the company, sub-contractors, financial controlling, measurement, technical support, programming language, operating system, database system, tool infrastructure	P22
External environment	Legal aspects, number of stakeholders, stakeholder availability, stakeholder background, requirements stability, client process, client availability, type of contract, user availability, user background, trainings	
Objectives	Complexity, degree Innovation, legacy system (documentation), domain, conceptual solution, technical solution, safety & security, hardware development, software ecosystem, user interface, system integration test	

- (P21) Clarke and O'Connor [66] proposed a comprehensive framework of the situational factors affecting the software development process. The factors presented in the research paper provide an initial framework for the key situational elements affecting the software process definition. No single general reference point for the situational factors of the software development process

was identified and their research was based on the seven following research domains: software development (SD) models and standards, risk factors for SD, SD cost estimation, SD environmental factors, software process tailoring, degree of required software process agility and software engineering body of knowledge. The results have been derived with the grounded theory method and the reference framework presents 44 factors grouped in eight high level classifications: *personnel*, *requirements*, *application*, *technology*, *organization*, *operation*, *management* and *business*.

- (P22) Kalus and Kuhrmann [67] performed a systematic review of literature with the aim of proposing a list of criteria for software processes tailoring. It is commonly accepted that any software process needs to be tailored to the particular project environment, as it becomes otherwise, a project risk. The objective of the research was to answer what are the characteristics of a project that should be considered for tailoring software processes. They proposed a list of 49 tailoring software process criteria grouped in four categories: *team*, *internal environment*, *external environment* and *objectives*.

5) AGILE METHOD TAILORING FACTORS

Two primary studies demonstrate specific factors and criteria and their classification that should be taken into account when pursuing agile method tailoring in the organizational processes. Tailoring in software process context may be observed as a customization based on aspects, objectives, culture, reality and environment of the organization conducting the tailoring process.

Two primary studies present situational factors related to agile method tailoring:

- (P1) Cao *et al.* [7] proposed a framework for adapting agile development methodologies. Two groups of factors should be taken into account in agile method tailoring: *sources of structure* and *internal system*. Method tailoring strategy in the presented framework defines guidelines to customize (tailor) agile method to fit the organizational structure. In Table 17, factors to be taken into account for agile method tailoring are presented. Based on sources of structure in the organization (structural processes, task characteristics and organizational requirements) and internal system of the organization (structure from organizational/team environment), agile practices should be customized appropriated) to meet organizational structure and to address the expected challenges.
- (P27) 18 method tailoring criteria and 6 method tailoring criteria classifications were identified in the systematic literature review [1], and exact criteria and their classification in the research study are presented in Table 17. Authors of this study aimed to evaluate, synthesize, and demonstrate research on criteria for method selection and approach towards agile methods tailoring. The method tailoring criteria presented in the primary study P27, was a continuation of the research of Kalus and Kuhrmann [67]. The agile method tailoring criteria presented in the results of Kalus and Kuhrmann was compared to the literature review. As a result of this research study, two additional agile method tailoring criteria groups (previous knowledge and maturity level), and six new method tailoring criteria (business goals, organization size, culture, previous projects, maturity level and communication) were identified. Software development processes are tailored during the agile adoption process. Research study of Campanelli and Parreiras [1] demonstrates the customization of general criteria (for software development process tailoring) to the concrete situation of agile method adoption, where majority of proposed criteria (for software development process) are applicable, but some new specific criteria should be taken into account for agile method adoption initiatives.

TABLE 17. Agile method tailoring factors and criteria.

Factor/criteria classification	Method tailoring factor/criteria	Primary study
Agile method tailoring factors	Process structure (structural features), task characteristics, organizational requirements, organizational environment structure, team environment structure	P1
Agile method Tailoring criteria classification	External environment, internal environment, objectives, team, previous knowledge, maturity level	
Agile method Tailoring criteria	Project type, business goals, complexity, team size, technology knowledge, user availability, requirements stability, organization size, culture, team distribution, management support, degree of innovation, previous projects, maturity level, domain knowledge, project budget, communication, type of contract	P27

V. DISCUSSION

In the Results section, the identified and analyzed data from primary studies have been presented. In this section obtained results are further analyzed and compared with the aim of deriving further conclusions and synergies. Discussion section is divided into three sub-sections, which are organized in line with the research questions. Section V.A presents examination and assessment of framework elements identified in the primary studies. Section V.B discusses issues and aspects classification identified in the primary studies. Finally, Section V.C shows an integrated and prioritized list obtained of situational factors for agile transition and adoption process.

A. DISCUSSION ON AGILE TRANSITION AND ADOPTION FRAMEWORKS

First research question (RQ1) addressed in this study is: *Which frameworks for agile transition and adoption exist in the literature?* Nine frameworks and systematic approaches were identified in the research literature. Detailed description of these frameworks and list of primary literature sources discussing frameworks have been presented in Section IV.A. In Table 18, a classification of framework elements is presented as a first step towards an encompassing analysis of the similarities and differences among encountered frameworks. The identified frameworks vary significantly in their approach towards agile transition and adoption process. Frameworks present a systematic approach towards agile transition process and it is a complex, organization and project context dependent process. Identified classifications in frameworks are focused on different aspects of the agile transition and adoption process.

Each of the identified frameworks demonstrates a specific approach to agile adoption process such as: proposing the set of activities to be pursued, demonstrating strategies to be employed, the expected stages to go through, challenges and issues to overcome and the practices to be used. Therefore, frameworks as a whole were not directly comparable since most of them focused on different perspectives. Moreover, what is considered a framework in one research study is different in other research study. In fact, the conception of the idea for framework varies. For instance, in one research study framework could be used as a supporting tool for agile transformation, but in another study, only the expected stages during the transformation process are defined in the framework.

The research questions in this article aimed at gathering all the issues and perspectives discussed in the literature, and relevant to keep in mind when performing agile transformation and adoption process. Since general frameworks as a whole were not comparable directly, their main research contributions and the set of classifications proposed are shown in Table 18, and in the rest of this section the framework elements (and not frameworks as a whole) are compared and discussed.

The framework from Cao *et al.* [7] for adapting agile development methodologies recommends the appropriated agile practices to accommodate identified groups of challenges during the transformation process: development process, customer, developer and organization/management.

The framework from Gandomani and Nafchi [20] for agile transition and adoption demonstrates four underlying concepts and, among them, transition challenges and issues: negative human aspects, inadequate and dysfunctional training, customer issues and technical issues. Prerequisites needed to initiate agile transition process were another underlying concept of the same framework: having convincing reasons for change, defining business goals, people buy-in, initial

TABLE 18. Agile transformation framework classifications/elements identified in the primary studies.

Primary study	Framework contribution	Framework elements/groupings
P1	Appropriated practices for challenge groups. Demonstrates influence on social interaction and social structure.	1. Development process related challenges 2. Developer related challenges 3. Customer related challenges 4. Organization/Management related challenges
P2	Based on the level of project independencies, team size and volatility, appropriate method should be chosen.	Choose appropriate method: 1. Plan driven 2. Hybrid 3. Agile Evaluate level of project: 1. Interdependencies 2. Team size 3. Volatility
P3	Framework based on knowledge management factors that identifies factors influencing the acceptance of agile methodology.	1. Ability – related factors 2. Motivation – related factors 3. Opportunity – related factors 4. Agile methodology characteristics 5. Knowledge management outcomes
P4	Three main contributions were presented in the article regarding agile adoption: 1. Strategy types 2. Adoption stages 3. Dependencies and synergies between practices	1.1. Incremental Vs. Wholesale 1.2. Bottom-up Vs. Top-down 2.1. Preliminary activities 2.2. Implementation activities 3.1. key practices 3.2. Synergy effects
P5	1. Agile Software Solution Framework (ASSF) 2. Agile Adoption and Improvement Model (AAIM)	1. ASSF is high overview Framework to support the evaluation, adoption and improvement of agile methods in practice. 2. AAIM - sequential levels and practices to be implemented.
P6	1. Four main concepts underlying concepts for Agile Transition and Adoption process. 2. Four steps for agile transition and adoption model based on PDCA approach.	1.1. Agile transformation key prerequisites 1.2. Agile transition facilitators 1.3. Transition challenges and issues 1.4. Agile transition and adoption framework characteristics and 5 activities: 1.4.1. Practices selection 1.4.2. Adapting 1.4.3. Assessment 1.4.4. Retrospective 1.4.5. Adjustment
P7	Agile adoption framework consists of two main parts: 1. Sidky agile measurement index (SAMI) 2. 4-Stage process of the adoption framework	1. SAMI consists of five levels: Level 1 – collaborative Level 2 – Evolutionary Level 3 – Effective Level 4 – Adaptive Level 5 – Encompassing 2. 4 – stages process consists of following stages: Stage 1 – go/no-go decision Stage 2 – Project level assessment Stage 3 – Organizational assessment Stage 4 - Reconciliation

TABLE 18. ***(Continued.)*** **Agile transformation framework classifications/ elements identified in the primary studies.**

P8	Framework for anticipating the attainability of the objectives of a development method in a particular project situation. It consists of: 1. Method Fragment Repository 1.1. Objectives dataset 1.2. Requisites dataset 2. Model Fragment Repository	Evaluation framework of attaining the objectives consists of the following steps: A. Retrieve model fragments (1.) B. Merge model fragments C. Customize integrated model (2.) D. Evaluate customized model
P9	Conceptual framework that can improve method tailoring effectiveness, consists of two sets of factors: 1. Method characteristics improving the effectiveness of method tailoring 2. Developer practices improving the the effectiveness of method tailoring	Four method characteristics are presented: 1.1. Explicit statement of method boundaries 1.2. Contingency built in to method itself to guide tailoring 1.3. Clear description of method and rationale behind method practices 1.4. Independence of individual method practices Three developer practices are presented: 2.1. Identification of project context dependencies 2.2. Familiarity with a range of methods and method fragments 2.3. disciplined and purposeful approach to method tailoring

training, pilot project selection, pre-start assessment and team set-up. In the same manner, another framework [60] brings up the importance of requisites, where situational evaluation of method fragments is presented. Repository of fragments that consists of objective dataset and requisites dataset - conditions to be met for successful enactment of method fragment.

Agile method characteristics chosen for adoption in the organization are identified as a significant factor influencing the transformation process. Method tailoring effectiveness may be improved and is influenced by two factor groups [47]: method characteristics and developer practices. Method fragment repository [60] also depends on specific method characteristics, and in other conceptual framework presented in [43] direct influence of agile methodology characteristics on acceptance of agile methodology is presented.

Context of the project and project environment (organization) are important perspectives in the agile transformation process. Cao *et al.* [7], in their framework, focus on the adoption of methodologies depending on specific circumstances. The framework of Barlow *et al.* [42] aims to explain theoretically the greater or smaller suitability of the agile techniques for specific types of environment. Based on the project level of interdependencies, the team size and its volatility, the appropriate method may be chosen for the company transformation: agile, traditional or hybrid. Situational factors influencing the adoption process are demonstrated in the research study [43] where knowledge management outcomes are brought in relation with acceptance of the agile methodology.

General agile adoption strategies identified in [44] were: incremental vs. wholesale and bottom-up vs. top-down. In the reviewed literature, authors identified agile adoption stages. Frameworks from primary studies propose the following agile adoption phases:

- preliminary and implementation [44],
- go/no-go decision, project level assessment, organizational assessment and reconciliation [45], and
- prompt, crux and apex [59].

Diverse perspectives underlay the agile adoption stages defined in the identified frameworks. Go/no-go decision from the framework presented in [45] might be considered as a preliminary phase proposed in [44], but prompt as a first stage of the framework presented in [3] proposes the implementation of practices without preliminary activities.

Measuring the agility level of the project and in the organization is an activity embedded in some of the frameworks: 5 levels of agility SAMI-tool [45], 4 levels embedded in 4-DAT tool [59]. The proposed tools for measuring agility provide an information to be used for strategic decisions during the transformation process.

The activities to be performed during the transformation process were discussed by [60], where four activities of agile method integration are shown: retrieving model fragments, merging model fragments, customizing integrated model and evaluating customized model. In another example of agile adoption activities, based on ''Plan-Do-Check-Act'' cycle of Deming, 5 activities for agile transition and adoption are derived [20]: practices selection, adapting, assessment and retrospective and adjustment. In the AAIM tool [3], the agile practices to be integrated based on agility levels are presented, and similarly, the SAMI tool [45] suggests the agile principles to be implemented based on the project and organizational agility level.

B. FACTOR CLASSIFICATION IN AGILE TRANSITION AND ADOPTION

The second research question (RQ2) addressed in this study is: *Which issues and aspects are discussed in agile transition and adoption literature, and how can they be grouped and organized?* In the results section, the identified issues and aspects that should be considered when performing an agile adoption initiative have been presented and classified into different sections in a logical manner. In this section, factor types influencing the agile transition and adoption process are presented. Factor types and classifications identified in the primary studies are analyzed and presented in Table 19.

First column presents the *factor types*, which are a result of the analysis and grouping performed by the authors of this study. Second column shows the *classifications* identified in primary studies, clustered to fit *factor type*s. Third column

TABLE 19. Factor type and classifications identified in primary studies.

Agile adoption factor types	Classifications identified in the primary studies	Primary source
1. Method selection	Project environment	P2
	Agile methodology characteristics	P3
	Project situation	P17
2. Agile method tailoring	Agile method tailoring factors	P1
	Perception on agile methods	P18
	Agile method tailoring criteria groups	P27
3. People	Ability	P3
	Motivation	P3
	People factors	P19
	Personnel	P21
	People	P28
	People-related	P28
4. Project	Opportunity	P3
	Team	P22
	Internal environment	P22
	Project	P23, P28
5. Organizational (External to project)	Organizational factors	P19
	Management	P21
	Organization	P21, P28
	Project environment	P23
	System	P28
6. Client (External stakeholders)	Client integration	P26
	Requirements	P21
	Operation	P21
	Business	P21
	External environment	P22
7. Knowledge management	Knowledge management	P3
	Communities of practice existence	P15
8. Product and technology	Technology	P21
	Application	P21
	Objectives	P22
	Product architecture	P28

demonstrates primary study source where classification was identified.

Primary studies demonstrate various approaches to agile transition and adoption process, and they discuss different perspectives and offer different solutions and guidelines for the complete process of organizational change, and/or they suggest specific activities and practices to be implemented for agile adoption process phases. Different classifications have been encountered in primary studies, depending on their research objective and structure of the research study. Therefore, under term *classification* we have gathered different groupings and divisions of issues, aspects, factors, challenges and activities.

The first factor type, 1. Method selection, involves three classifications of factors from primary studies. The project situation, its environment and the methodology characteristics are used to determine the adequacy of the method to be integrated in the organizational processes. Based on these factors, the most adequate method may be chosen for a specific project (traditional, hybrid or some of the agile methods).

The second factor type, 2. Agile method tailoring, involves three categorizations identified in the primary studies. This factor type integrates situational factors, group of factors and criteria that should be used for agile method process tailoring initiatives. While the first factor type provides factors to select the right method for a specific context, the second factor type provides factors for business process tailoring of a specific agile method or methods. Factor type 1 gathers factors for the contingency-based method selection proposed by Conboy and Fitzgerald [47] (the appropriate method is selected based on the contingency factors) and factor type 2 gathers factors for the method engineering approach (the agile method is reengineered to fit the specific context of the project).

The third factor type, 3. People, involves six groupings from the primary studies. Groupings in this section are related to people, roles and individual motivation and abilities. People factor type presents factors related to each organizational role [62], and people-related factors from the same research provide a perspective on individual aspects and interactions among people. Similarly, personnel classification of factors in [66] brings into perspective individual skills and interaction but, in addition, the team aspect is embedded. Similarly, in [65] people factor type individual perspective and interaction factors are embedded, and in addition, training and learning is explicitly mentioned, similarly to the ability related factors classification in [43] Motivation related factors from the same research focus on people motivation and individual opportunities.

The fourth factor type, 4. Project, involves four classifications from the primary studies. Project factors in [62] and in [64] present factors related to the project such as cost, criticality, duration and urgency. Some team factors such as team collocation and experience level are also involved, but in the research from [67], team classification factors add previous cooperation, turnover and knowledge into perspective. Moreover, in the same study, internal environment classification presents project factors presented in [62] and [64] but, in addition, organizational and infrastructural process factors are added. Opportunity classification [43] focus on personal factors in team.

The fifth factor type, 5. Organizational, involves five categorizations from the primary studies. Organizational factors as a classification are identified in [62], [65] and [66]. They are focused on client issues, organization culture, size, maturity, stability, facilities, technical environment, business and planning and controlling processes. In addition, team aspects (size and distribution) and management aspects are mentioned, which may be found in factor type 3 and 4 in other classifications. Project environment factors in the research of [64] and system quality and legacy system from the research study of [62] are also related to organisational factor type.

The sixth factor type, 6. External stakeholders, involves five groupings from the primary studies. Five principles influencing the user and client integration in agile software development processes are shown in [11], external environment classification in the research from [67] focuses on client, user and general stakeholder aspects. It can be noticed that external environmental factors in this research are related

to aspects of project environment (external to project but within organization), but also external to the organizational environment. In the case of project environment factors [64] the focus was on factors external to the project but related to the internal organization. Requirements, operation and business classification in the research from [66] also refer to customer and end-user perspective, business drivers and general requirement process.

The seventh factor type, 7. Knowledge management, involves two classifications from the primary studies. Knowledge creation, retention and transfer in the organization are presented as important factors for the acceptance of an agile methodology [43]. Moreover, in the study conducted at Ericsson, communities of practice influenced positively on the agile adoption process and continuous organizational improvements, and it served as a significant knowledge sharing tool [61].

The eighth factor type, 8. Product & Technology, involves four groupings from the primary studies. Product or application related issues such as type, complexity, reuse, quality, size, performance, degree of risk are presented in application classification [66]. In the same research study, technology classification presents technology knowledge and emergence, product architecture classification. In [62], the research focus was on product architecture factors such as quality, scope, value, defects and increment. Objectives classification [67] presents factors mostly related to product characteristics such as complexity, degree of innovation, domain, conceptual solution, user interface, system integration test and safety and security.

Factors influencing team, project and organizational roles are often distributed differently in various research studies and it depends on the point of view of the author and its general factor type classification.

C. SITUATIONAL FACTORS AFFECTING THE AGILE TRANSITION AND ADOPTION PROCESS

The third research question (RQ3) is: *Which are the situational factors affecting agile transition and adoption process?* Specific situational factors belonging to each classification group in the primary studies have been analyzed and ordered by frequency of appearance in Table 20. This table collects the situational factors identified relevant for the agile transformation and adoption process. Top of the table starts with factors having the highest number of references towards those with least. Each group of factors (factors with eight sources, factors with seven sources, etc.) are alphabetically ordered.

In order to determine the most important situational factors we considered the ones addressed in three or more primary studies. Then, according to the quality score of each primary study (from the quality assessment criteria in Table 5), we calculated the rate of each factor. The sixteen main situational factors are listed in Table 21. Organizational culture, also named corporate culture, has been identified as the

TABLE 20. Situational factors identified in primary studies.

Situational factor	Primary study
Organizational/corporate culture	P3, P17, P18, P19, P21, P23, P27, P28
Team size/scale	P2, P17, P21, P22, P23, P26, P28
Management support	P3, P14, P22, P23, P27
Training	P3, P6, P19, P22, P23
Previous experience	P3, P21, P27, P28
Project budget/cost	P22, P23, P27, P28
Team distribution/co-location	P22, P23, P27, P28
Communication	P3, P27, P28
Contract type	P22, P23, P27
Customer collaboration/involvement	P19, P23, P28
Domain knowledge/expertise	P22, P27, P28
Organization maturity level	P21, P27, P28
Organizational instability/dynamism/turnover	P17, P21, P23
Previous knowledge/expertise/skill	P21, P27, P28
Project criticality	P17, P23, P28
Project time/duration	P22, P23, P28
Business goals	P27, P28
Complexity	P21, P22
Customer satisfaction	P19, P21
Degree of innovation	P22, P27
Financial control	P19, P22
Learning	P19, P28
Management commitment	P14, P21
Organization size	P21, P27
Organizational requirements/scope creep	P1, P21
Organizational/internal environment structure	P1, P27
Personal characteristics	P17, P19
Project complexity/interdependencies	P2, P27
Project size	P23, P28
Project type	P22, P27
Requirements uncertainty/stability	P23, P27
Shared understanding	P3, P22
Team characteristics/structure	P1, P18
Team coordination/collaboration/cohesion	P21, P28
Team maturity and experience level/previous cooperation	P22, P23
Team procedural empowerment	P6, P23
Team volatility/turnover	P2, P22
Teamwork/collaborative work	P3, P18
Technology knowledge	P22, P27
User availability	P22, P27
Agile champions	P6
Application size	P21
Architect – role, responsibility, background and experience	P28
Architecting value and cost	P28
Architectural defects	P28
Architectural increment	P28
Architectural quality	P28
Architectural scope	P28
Arduous relationship	P3
Business drivers	P21
Business external dependencies	P21
Career consequences	P3
Clear project proposal	P22
Client availability	P22
Client process	P22
Commitment	P21
Communities of practice existence	P15
Compliance and governance factors	P23
Conceptual solution	P22
Connectivity	P21
Continuous meetings and negotiations	P6
Continuous tailoring of business processes	P14

TABLE 20. *(Continued.)* **Situational factors identified in primary studies.**

Customer perceptions	P18
Database system	P22
Degree of risk	P21
Deployment profile	P21
Developer – attitude and behavior	P28
Developer perceptions	P18
Development phase	P21
Disharmony	P21
Domain objectives	P22
End-users	P21
External environment	P27
External support	P3
Facilities	P21
Feasibility	P21
Good coaching and mentoring	P6
Hardware development	P22
Incentive factors	P22
Knowledge creation	P3
Knowledge retention	P3
Knowledge transfer	P3
Legacy system	P28
Legacy system (documentation)	P22
Legal aspects	P22
Magnitude of potential lose	P21
Management accomplishment	P21
Management availability	P22
Management buy-in	P6
Management continuity	P21
Management expertise	P21
Management vision, awareness and understanding of agile methods	P14
Measurement	P22
National/societal culture	P19
Number of stakeholders	P22
Operating system	P22
Payment arrangements	P21
Perceived compatibility of Agile method	P3
Perceived ease of use of Agile method	P3
Perceived maturity of Agile method	P3
Perceived usefulness of Agile method	P3
Performance	P21
Personal skills	P23
Power distance	P23
Predictability	P21
Prerequisites	P21
Process knowledge	P22
Process structure	P1
Programming language	P22
Project goals confliction with stakeholder expectations	P28
Project governance	P28
Project opportunities	P21
Project rate of change	P28
Project role in the company	P22
Project urgency	P23
Proportion of the organization affected	P23
Prototyping	P22
Quality	P21
Requirement stability	P22
Result demonstrability of Agile method	P3
Reuse	P21
Right people selection	P22
Rigidity	P21
Safety & security	P22
Software development method self-efficacy	P3
Software ecosystem	P22
Stability	P21
Stakeholder availability	P22
Stakeholder background	P22
Standard	P21

TABLE 20. *(Continued.)* **Situational factors identified in primary studies.**

Project urgency	P23
Proportion of the organization affected	P23
Prototyping	P22
Quality	P21
Requirement stability	P22
Result demonstrability of Agile method	P3
Reuse	P21
Right people selection	P22
Rigidity	P21
Safety & security	P22
Software development method self-efficacy	P3
Software ecosystem	P22
Stability	P21
Stakeholder availability	P22
Stakeholder background	P22
Standard	P21
Structure	P21
Sub-contractors	P22
Subjective norm	P3
Support from stakeholders	P28
System integration test	P22
System quality – complexity and safety	P28
Task characteristics	P1
Team autonomy for agile methods tailoring	P14
Team members buy-in	P6
Team productivity	P21
Technical environment	P28
Technical solution	P22
Technical support	P22
Technological uncertainty	P23
Technology emergent	P21
Technology knowledge	P21
Time to market	P21
Tool infrastructure	P22
Tool knowledge	P22
Type	P21
User background	P22
User integration	P26
User interface	P22
Voluntariness	P3

first situational factor influencing the agile transition and adoption process. Team size or team scale is the second situational factor and management support is the third one, followed by training and project budget or cost.

VI. THREATS TO VALIDITY AND LIMITATIONS

Literature has reported several threats of validity in systematic mapping studies [68]. Petersen *et al.* [56] identified the following threats of validity in these studies: descriptive validity, theoretical validity and interpretive validity. In what follows, these threats of validity are discussed.

The descriptive validity is the extent to which observations are described in an accurate and objective way. Researchers collected studies by means of a data extraction form to record data in order to control this threat.

The theoretical validity might be incomplete due to the fact that this review was done in 2018. Apart from that, researcher biases may also be present in the study in the phases of selection and extraction of data. To reduce this threat, authors followed a process to involve all researchers in the selection process and applied the Krippendorff alpha statistic to show a high agreement among them.

TABLE 21. Main situational factors.

Order	Situational factor	Rate	Quality scores of primary sources
1	Organizational/corporate culture	71	8(P3) + 9(P17) + 9(P18) + 9(P19) + 9(P21) + 8(P23) + 10(P27) + 9(P28)
2	Team size/scale	63	9(P2) + 9(P17) +9(P21) + 10(P22) + 8(P23) + 9(P26) + 9(P28)
3	Management support	46	8(P3) + 10(P14) + 10(P22) + 8(P23) + 10(P27)
4	Training	44	8(P3) + 9(P6) + 9(P19) + 10(P22) + 8(P23)
5	Project budget/cost	37	10(P22) + 8(P23) + 10(P27) + 9(P28)
6	Team distribution/co-location	37	10(P22) + 8(P23) + 10(P27) + 9(P28)
7	Previous experience	36	8(P3) + 9(P21) + 10(P27) + 9(P28)
8	Domain knowledge/expertise	29	10(P22) + 10(P27) + 9(P28)
9	Contract type	28	10(P22) + 8(P23) + 10(P27)
10	Organization maturity level	28	9(P21) + 10(P27) + 9(P28)
11	Previous knowledge/expertise/skill	28	9(P21) + 10(P27) + 9(P28)
12	Communication	27	8(P3) + 10(P27) + 9(P28)
13	Project time/duration	27	10(P22) + 8(P23) + 9(P28)
14	Customer collaboration/involvement	26	9(P19) + 8(P23) +9(P28)
15	Organizational instability/dynamism/turnover	26	9(P17) + 9(P21) + 8(P23)
16	Project criticality	26	9(P17) + 8(P23) + 9(P28)

Finally, regarding interpretive validity, it concerns with the connection of conclusions with the data. While it is true that this threat appears in every systematic mapping, the experience with tertiary studies is the main aspect to tackle this threat of validity.

VII. CONCLUSION AND FUTURE WORK

Research objectives of the study were designed to identify various aspects of agile transition at different levels. Firstly, general methodological approaches (frameworks) for the whole transition process were observed. Secondly, a specific group of issues and aspects of the agile transformation process - providing deeper understanding of specific perspectives and groups of issues in the transformation process were observed. Lastly, a more detailed perspective was investigated and, as a result, situational factors affecting the agile transition and adoption process were identified.

Different contributions to the research community and experts from industry can be derived from this research. Conclusions related to each contribution are presented in the next paragraphs. Moreover, future works from the obtained results are stated below.

First contribution is related to the identified agile transformation and adoption frameworks. These frameworks significantly vary in their approaches. Some frameworks consist of elements and tools to evaluate the situation in the organization and to provide guidelines on how to pursue the general process of the transformation. Other frameworks focus on specific aspects of the transformation process, rather than on the general process. A summary of identified frameworks is presented in Section IV.A. A direct comparison of identified frameworks was not possible due to their difference in research focus and provided perspective on the transformation process. However, a comparison at a lower level (framework elements and framework aspects) was done to draw conclusions on frameworks and their structural approaches towards agile method adoption process. The results of the framework comparison and analysis is presented in Section V.A. For future research initiatives, we suggest the creation of a comprehensive framework encompassing classifications and issues identified in this paper. The resulting framework should present the high level (strategic) approach of the agile adoption process and propose various transformation paths (strategies) and guidelines for practitioners based on the context in the organization and the project where agile adoption is being conducted.

The second contribution of this work is the analysis of the issues affecting agile transition and adoption process. Sections IV.B, IV.C, IV.D and IV.E present the proposed classification of identified aspects. These results provide a useful repository (analysis and comparison) of issues and encountered practices used by practitioners in agile adoption process. Each section is a useful source for settings planning to pursue an agile adoption process Thus, practitioners can find on one place typical challenges and useful practices for agile adoption identified in the literature. Section IV.B presents potential activities to be conducted before the initiation of the agile adoption process, such as measuring the level of agility in the company, selecting the overall adoption strategy or identifying hindering factors for agile adoption. Section IV.C demonstrates typical obstacles and challenges, but also, results of the agile adoption process. Section IV.D presents different stages of transformation and activities to be performed within different stages and in the general agile adoption process. Section IV.E presents most used agile practices in the agile transformation process. When we started the research, it was expected to identify situational factors affecting the agile transition process. However, many other aspects and issues typical for agile adoption process were encountered and classified in logical groups. The proposed classifications may be used for future research as a basis for further research initiatives and in-deep analysis of each classification.

The identified situational factors affecting the agile adoption process presented in Section IV.F, and their classification demonstrate the third contribution of this study. Situational factors for agile method selection presented in Section IV.F.1 may be used by practitioners who decide to follow a contingency adoption approach in the organization - adopting agile method based on contingency factors identified in the organization before the initiation of the

agile transition process. Alternatively, if method engineering approach is used in the organization (engineering and tailoring of available agile methods to fit specific needs of the organization) then situational factors presented in Sections IV.F.2, IV.F.3, IV.F.4 and IV.F.5 may be used in the agile adoption process. Section IV.F.2 presents situational factors supporting the agile adoption and expected results of the agile transformation process. Section IV.F.3 shows situational factors for agile software development, and IV.F.4 shows general software development factors and criteria. Section IV.F.5 demonstrates agile method tailoring factors.

The identified situational factors affecting the agile transformation and adoption process was presented in an integrated list of 154 factors. Data analysis and comparison at the level of situational factors was a successful research initiative resulting with an integrated list ordered by number of sources. It may be used in practice, or for future research initiatives. As a future work, the integrated list of situational factors may be verified and evaluated in the organizational setting, and different prioritization of factors may be established based on the results. Moreover, situational factors are classified in this study, but further regrouping of factors (higher-level), and further integration of the proposed list of factors may be performed as a future work.

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