Critical Success Factors of Agile Transformation Initiatives from a Project Management Perspective

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ABSTRACT

Context: Agile methods have been adopted as an alternative to meet the frequent changes in the IT industry and to address issues of quality, cost, speed, and efficiency in systems development processes. _Problem_: Managers are responsible for the appropriate application of knowledge, skills, tools, and techniques that can impact the success or failure of an agile transformation initiative. However, there is not much visibility into the critical success factor (CSF) associated with it. _Solution_: We aim to identify the CSF that affect agile transformation initiatives from a project management perspective. _IS Theory_: The General Systems Theory provides the basis for this study since the organizational aspects involved in the agile transformation are interrelated and influenced by factors such as environment, culture, information technology, internal management systems, and other elements that may hinder its adoption. _Method_: We performed a systematic mapping study in the following digital databases: EI Compendex, IEEE, ISI Web of Science, and SCOPUS. _Summary of Results_: We identified 12 CFS based on 12 studies. The most cited ones were top management support, team empowerment, adapting the process to agile, and customer focus. Adoption of participatory management, good communication, and building strong teams are among the least mentioned CSF. _Contributions and Impact in the IS Area_: Our results can help organizations in new agile transformation initiatives. Such CSF are interrelated and, if taken into consideration, have an essential effect on the success of the agile transformation. Moreover, management should consider the business through a systemic and holistic view because those CSF can positively impact agile transformation.

CCS CONCEPTS

• **Software and its engineering** → **Agile software development**;
• **General and reference** → _Surveys and overviews._

KEYWORDS

Agile Transformation, Agile Software Development, Critical Success Factors, Project Management

1 INTRODUCTION

Agile methods have been adopted in recent years to meet the constant changes in the Information Technology (IT) industry and to overcome the restrictions imposed by traditional software development methods [21, 30]. According to the "15th State of Agile Report" [12], there was a considerable increase in the adoption of agile methods in all functions within organizations. Considering only software development teams, the increase was from 37% in 2020 to 86% in 2021. The growth in the number of organizations adopting agile practices and processes indicates that the trend should remain [8, 21, 32, 39].

Agile Transformation (or Agile Transition, Agile Implementation or even Agile Adoption) denotes changing the traditional process to the agile one, which can be implemented in an isolated way in a sector or the whole organization [30]. Despite the simplicity of its definition, the agile transformation itself may not be that simple [18], mainly because there are significant changes in the organization, even considered as organizational mutation [17]. It is not enough to want to change and improve the software development process: understanding the many aspects involved is necessary, as this is not a routine activity for organizations.

There are definitions in the literature from the General Systems Theory (GST) that seek to explain the complex and interdependent phenomena involved in organizations. From the systemic point of

view, the organization is represented as a whole, with resources and an internal and external environment [31]. Thus, the organization can be understood as a system composed of interrelated parts and the complexity of its activities, processes, people, and external entities, besides a large number of manipulations of different types of information [2, 31].

For this reason, agile transformation is not a mere improvement or change in the software development process from traditional to agile [19], as implementing improvements in a software process involves a sociotechnical system [19], in addition to being a complex sociocultural phenomenon [25], with overlapping and interdependent factors, which are not limited to techniques, methods or practices. Agile transformation occurs in processes, people, and the organization.

There are critical success factors (CSF) that permeate agile transformations [14, 23]. Broadly speaking, CSF are characteristics, conditions or variables that can significantly impact the organization's success when properly maintained or managed. Some authors consider that the CSF are related to the keys to success, but the idea of success extends to a few areas and is essential for a manager to achieve his goals. These critical areas deserve management attention, whose relevant information results in better managerial performance [3]. Toledo et al. [37] suggest that the degree of success of a project depends on factors associated with management practices during the project's development. In that case, the perspective of success relates to methods that help achieve organizational goals and staff objectives but depend on other elements and internal and external conditions. This constitutes a robust systemic component involving the interdependence of its parts [2].

Although the CSF in the agile transition is referenced in scientific research, the project management perspective is little addressed. Thus, we conducted a systematic mapping study (SMS) to identify the CSF that influence an agile transformation's success and/or failure from a project management perspective and what effects are generated from them.

We identified 12 critical success factors. Top Management Support, Team Empowerment and Adapting the Process to Agile are the most mentioned. Among the least quoted, but no less important, are those focused on Good Communication and Building Strong Teams. Among the effects generated by the CSF method related to the agile transformation from the perspective of project management, the Commitment to Change stands out, being the most cited, as this effect encompasses different aspects of management, such as the change from command and control management to collaborative one [1] and a change in the manager's mindset, especially at the managerial level [6].

As a contribution, we expect that the list presented in this work, with the 12 CSF and the set of 17 effects, can help organizations that develop software in their agile transformation journey. Occasionally, the results presented can serve as a reference for project managers who wish to improve the performance and success of agile adoption, from planning to decision-making in the software development processes of their organizations.

Besides this introductory section, this paper is organized as follows: Section 2 presents and compares some work-related studies; Section 3 outlines the study planning and execution; The next Section 4 presents the study´s results; Section 5 shows the discussion and, finally, in Section 6 we present the final considerations.

2 RELATED WORKS

Secondary studies related to the theme close to this study were found. However, none of them aimed to identify CSF from a management perspective.

Dikert et al. [14] present a SMS on agile transformation and the use of agile methods on a large scale. Thirty-five challenges for agile transformation were identified and grouped into nine categories, and 29 success factors were into 11 categories. Among the success factors, the following can be highlighted: (i) managerial support; (ii) choice and customization of the agile approach; (iii) training and coaching; and (iv) mindset and alignment. The authors do not specify the success factors as being CSF, nor do they present a discussion from this project management perspective.

Lacerda and Furtado [23] present a study on factors that help implement agile methods. Barriers, benefits and difficulties influence the agile transformation but are not addressed as CSF or from a project management perspective. The aspects described are related to organizational culture and resistance to change.

Jovanović et al. [21] present the agile methods and practices use raising questions, problems and factors that affect the change in processes concerning successful agile practices. The authors classify the findings into five categories and present 154 situational factors identified in different domains representing the context influencing the transition process and agile adoption. Among the mentioned factors are: (i) training and mentoring; (ii) selecting the right people; (iii) team empowerment; and (iv) organizational culture. Even though it is implicit that these listed factors are CSF, the study does not contemplate the project management perspective.

Although related works have not discussed the management perspective, some factors are mentioned in this study, such as (i) top management support [7, 24, 32, 33, 36], (ii) team empowerment [1, 20, 26, 36] and (iii) adapting the process to agile [1, 6, 36].

3 RESEARCH METHOD

An systematic mapping study (SMS) provides an overview of a research area, identifying the number and types of searches performed, available results and frequency of publications over time to identify trends [28]. A well-defined methodological procedure makes it less likely that the results found in the technical literature are biased [22]. This type of study helps map study areas where it is difficult to picture the range of materials that may be available. In addition, conducting an SMS requires following a set of sequenced and well-defined steps.

Conducting the SMS involved three stages [28]: (i) **Planning**: definition of the mapping protocol; (ii) **Execution**: identification and evaluation of primary studies according to criteria defined in the protocol; and (iii) **Report of Results**: extraction of data from the primary studies to be presented.

3.1 Planning

At this stage, the research protocol [28] was defined, containing the study's objective, research questions, digital libraries to be used,

search string, study selection criteria, and data extraction procedure. Before defining the protocol, an ad-hoc literature review was performed with the following objectives: to identify any secondary studies addressing the same research topic that could make this study unfeasible; determine a set of control studies that served as a valid basis for the studies returned in the search databases; and identify studies that helped to define the first version of the search string used (validation of the final version of the search string is discussed in Section 3.1.4).

3.1.1   Objective. We defined the study objective, based on the GQM paradigm (Goal-Question-Metric) [5], as **analyzing** the academic literature **with the purpose of** characterizing **with respect to** critical success factors **from the point of view** of project management **in the context of** agile transformation initiatives.

3.1.2   Research Questions: We sought answers to the following research questions (RQ):

- **RQ1**: What are the critical success factors influencing an agile transformation's success and/or failure from a project management perspective?
- **RQ2**: What are the effects generated by the critical success factors related to an agile transformation from a project management perspective?

3.1.3   Search Procedure. The digital libraries were accessed via the Web through pre-established expressions. We searched SCOPUS, IEEE Xplore, El Compendex, and ISI Web Of Science. We selected them because they are relevant repositories for the area of Computer Science and Information Systems[15]. '

3.1.4   Search String. As this study represents a mapping study, the search string was defined according to three of the four aspects indicated in [28]: PICO (Population, Intervention, Comparison, Outcomes), according to the structure below:

- ***Population***: studies that refer to the target audience of the investigation, i.e., "project management".
- ***Intervention***: studies that refer to the specific aspect of the investigation, i.e., "agile transformation".
- ***Comparison:*** does not apply.
- ***Outcomes:*** studies that refer to research results, i.e., "critical success factors".

In an ad-hoc literature review, we identified two studies [13, 30] that use terms related to the themes of this mapping study. We used them to define the initial set of keywords associated with the three aspects of PICO above. We also identified two control studies [7, 32]. Tests were performed using the SCOPUS database to assess the accuracy and calibrate the string. The search string final version was: *(manag*) AND (agile AND (adoption OR transformation OR transition)) AND ("success factor" OR factor OR factors OR strategy OR strategies).*

3.1.5   Selection Procedure. Selection criteria are defined to exclude and include research-relevant studies. A single inclusion criterion **IC1** was defined: The study addresses critical success factors related to the agile transformation from a project management perspective. The exclusion criteria (EC) were: **EC1**. Duplicate study; **EC2**. The study is not written in English; **EC3**. Non-peer-reviewed study; **EC4**. The study is not accessible in full text; **EC5**. The study refers

to the tutorial, round table, lecture, poster, book, preface to congress/conference proceedings, and short papers; **EC6**. The study has no focus on agile transformation from the management perspective in organizations that develop software; and **EC7**. The study refers to management at the project technical team level (i.e., Quality Assurance Engineer, Tech Lead, Product Owner).

The studies were selected in three stages: (i) preliminary selection and cataloging of the studies collected through the sources from the search expression and exclusion of studies framed in the exclusion criterion "EC1"; (ii) application of the first selection filter by analyzing the title, abstract and keywords and eliminating publications that met exclusion criteria EC2, EC3, EC4, EC5, EC6 or EC7; (iii) application of the second selection filter through a complete reading of the studies and reapplication of the exclusion and inclusion criteria. In the end, only studies that met inclusion criterion IC1 were included.

3.1.6   Data Extraction. We organized the data extracted from the studies in a template structured into three major groups: (i) study data, such as title, author(s), year and publication vehicle; (ii) data derived from the characteristics of interest stated in the research questions, such as the CSF mentioned in the study, the outcome of the CSF influence on the success or failure of the agile transformation and effects that the CSF causes on project management resulting from the agile transformation; and (iii) supporting data for a better understanding of the results, such as the correlation among the CSF, the project management perspective and agile transformation, the approach adopted for agile transformation, characteristics of the organizations mentioned, the research method used, and additional researcher comments.

We identified the relevant results in the studies mainly by filling in the fields related to the group (ii) mentioned above. We identified results that explicitly addressed the success factor or ideas that refer to these factors and their influence on the success or failure of the agile transformation from the project management perspective. We used a similar approach to extract the CSF effects.

For example, based on "the top management support was the most decisive driving factor for the success of the Agile Transformation. The top management support was visible, and proper training was provided to make the middle management understand their new roles in the Agile Transformation" [S02], and "management support is one of the success factors in Agile Transformation in organizations. It is essential for self-organizing agile teams to establish and flourish by senior management support, in terms of providing freedom and establishing an organizational culture of trust" [S03], we coded the critical success factor "Top Management Support" (F01). When studies stated that "the commitment to change as a top management support feature" [S02], and "management supports the changes needed in the software-development-related processes in order to optimize processes for agile methods" [S03], we coded "Commitment to Change" (E01) as effect of "Top Management Support."

All extracted CSF were organized in a spreadsheet with their definitions and characteristics. From this, we could analyze, interpret and organize each CSF and the effects generated by the CSF. Those with similar meanings and/or characteristics were grouped into a single CSF, we used a similar approach to grouped the CSF effects.

The studies selected after the second filter were stored in a database with the templates containing the extraction of synthesized data.

3.2 Execution

The execution of the SMS occurred between September and December 2022. The studies were selected according to the criteria established in the protocol. A spreadsheet was prepared with the extracted results and is available at https://doi.org/10.6084/m9.figshare.22306720.v1. Figure 1 represents the studies' search and selection process.
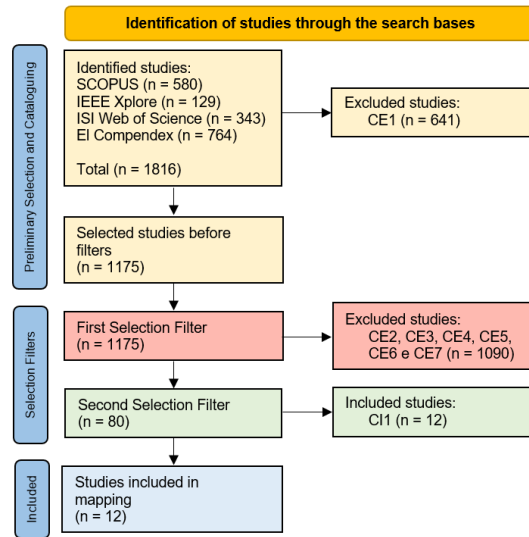

Figure 1: Studies' search and selection process based on the PRISMA approach [27].

Cohen's Kappa [10] coefficient was applied to measure the degree of agreement of the criteria defined in the protocol among researchers R1, R2, R3 and R4 to guarantee reliability during the selection procedure. Two groups were organized (each group formed by a pair), and after randomly selecting ten studies from the initial set of studies, each pair applied the Kappa.

Once the divergences were identified, each pair reached a consensus, and the Kappa coefficient was applied in both groups. The result obtained was a level of agreement equal to 0.74, indicating a substantial agreement among the researchers. To improve understanding, the EC6 exclusion criterion was readjusted without reapplying the Kappa [10] coefficient.

After that, the exclusion criterion "EC1 (duplicate study)" was applied. We excluded 641 studies, leaving 1175 studies for using the filters. When applying the first selection filter (reading the title, abstract and keywords), 1090 studies were excluded by the other exclusion criteria. Finally, 80 studies were selected for the second filter.

Each researcher R1, R2, R3 and R4 read 20 studies in total, applied the second filter and extracted the data. In the end, 12 studies were included in the second selection filter because they met the inclusion criterion IC1, according to Table 1. To guarantee uniformity during codification of CSF and their effects, the extracted data were

analysed by researchers R1 and R4. Then, researchers R2 and R3 reviewed the codification to assure mutual understanding.

Researchers R5 e R6 supervised the protocol definition and the study execution and report. In the end, we identified 12 CSF and 17 effects of these CSF. The results will be presented in the following section.

Table 1: Studies selected at the end of the review

ID	Study	Authors' country of filiation
S01	[4]	Canada
S02	[32]	Denmark
S03	[24]	Libya, Norway and Turkey
S04	[20]	Germany
S05	[1]	Palestine
S06	[6]	US and France
S07	[7]	Brazil
S08	[38]	United Kingdon
S09	[26]	Finland
S10	[33]	United Kingdon
S11	[11]	Finland and United Kingdon
S12	[36]	Sweden

4 RESULTS

The first results of this mapping refer to the characterization of the selected studies. Initially, data relating to the publication years are presented, ranging from 2010 to 2022, with any gaps, as seen in Figure 2. It should be noted that 4 (S07, S08, S10, and S12) of the 12 studies were published in conferences and the majority, 8 studies (S01, S02, S03, S04, S05, S06, S09, and S11), in journals. The most adopted research method is case study, with 10 studies (S01, S02, S04, S05, S06, S08, S09, S10, S11, and S12), while 2 studies present surveys (S03 and S07).
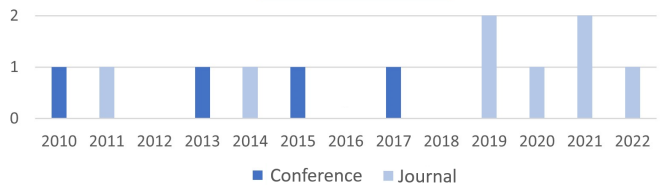

Figure 2: Years and places of studies publication

Concerning demographic aspects, 13 countries were identified that refer to the Origin countries of the studies' authors (affiliation), as seen in Table 1. The countries with the highest prevalence are the United Kingdom (3) and Finland (2). Another 11 countries contributed one study each.

4.1 Critical success factors (RQ1)

Regarding the research questions "*RQ1: What are the critical success factors influencing an agile transformation's success and/or failure from a project management perspective?*", 12 CSF were identified. Besides, it was possible to notice that all studies report that the CSF influences the success of the agile transformation. None of the identified studies dealt with the influence of agile transformation failure. Table 2 presents the identified factors and the studies in which they were reported.

Table 2: Identified critical success factors

ID	Critical Success Factor	Studies
F01	Top management support	S02, S03, S07, S10, S12
F02	Team empowerment	S04, S05, S09, S12
F03	Adapting the process to agile	S05, S06, S12
F04	Customer focus	S04, S05, S12
F05	Decentralized decision-making	S07, S11
F06	Team accountability	S01
F07	Team personal characteristics	S05
F08	Experimentation of new solutions	S06
F09	Servant leader mindset	S07
F10	Adoption of participatory management	S08
F11	Good communication	S11
F12	Building strong teams	S12

The identified CSF are presented below based on how the identified studies address them.

4.1.1 F01: Top Management Support. Support from the highest level of management and control of an organization in an agile transformation. Top management support was considered a success factor due to the managers' responsibility in making strategic decisions [S02, S10]. Effective endorsement from an organization's top management ensures access to resources and sharing with all the people involved in the agile transformation, supporting team empowerment and creating conditions for changes to occur [S07, S12]. In addition, the lack of support from top management may not achieve the success of a transformation [S03].

4.1.2 F02: Team Empowerment. Degree of freedom, confidence, motivation and engagement that the team experiences in an agile transformation given by the organization's top management. Team empowerment was seen from top management's behavior to promote the team's adaptability that is undergoing an agile transformation [S04]. Empowerment increases collaboration while allowing team members to transform the isolated development attitude into a collaborative environment, including sharing common interests and topics, which will support a successful agile transformation [S05, S09, S12].

4.1.3 F03: Adapting the Process to Agile. Effective adaptation of the process used by the organization in an agile transformation. Adapting to make it agile was understood in changing the development process and defining a strategy for implementing, planning and executing it in the organization [S05, S06]. Creating a more suitable approach for the organization is essential to drive the process as a success factor for a well succeeded agile transformation [S12].

4.1.4 F04: Customer Focus. Customer involvement in an agile transformation. The customer should be engaged, motivated, active, and responsible for the project [S05]. Customer-oriented management strategies in software development organizations strengthen customer involvement and collaboration with the team, generating influence for the success of an agile transformation [S04, S12].

4.1.5 F05: Decentralised Decision-Making. Autonomy of decisions given to the team where everyone is responsible for the decisions made. Decentralized decision-making was observed in the construction of sharing and learning environments that promote team decision-making [S11]. Self-organized teams are related to decision-making, learning new skills as the person plays different roles, and

the freedom to act as the team wants to achieve goals. Reaching autonomy to make decisions for the team is considered a success factor in an agile transformation [S07].

4.1.6 F06: Team Accountability. Team accountability refers to a relationship between a team and a project manager. This relationship is considered a critical success factor for agile transformation, as it establishes a delegation of responsibility and a requirement for "accountability" for the execution of this responsibility [S01].

4.1.7 F07: Team Personal Characteristics. Personal characteristics of the team and the client, such as a collaborative attitude, honesty, responsibility, readiness to learn, cooperation, technical experience and qualification, are required [S05]. They can interfere with and be necessary for agile transformation [S05]. For instance, some project participants have a progressive attitude, contributing to a social culture [S05].

4.1.8 F08: Experimentation of New Solutions. One of the key success factors for a successful agile transformation is experimentation to enable teams to explore and test new ways of working to find more effective solutions to create value for the customer [S06].

4.1.9 F09: Servant Leader Mindset. The servant leader mentality was observed in the role of the project manager, who needs to change from a planner and controller to a team facilitator, focusing on collaboration, creativity and group decisions. This is essential for project managers acculturated to traditional software development approaches and undergoing an agile transformation process [S07].

4.1.10 F10: Adoption of Participatory Management. A management style that motivates and involves the team to achieve alignment between agile transformation and business strategies. People need to perceive the adherence to participatory management to feel involved in the agile transformation and understand what adjustments can be made to support the proposed new processes [S08].

4.1.11 F11: Good Communication. Project managers must have communication skills when transmitting information to the team clearly, objectively and precisely. Good communication in an agile transformation generates greater engagement among team members and increased productivity [S11].

4.1.12 F12: Building Strong Teams. Formation of teams by the organization with members trained in knowledge and technical skills and positive attitudes towards organizational and cultural changes. Building strong teams aligned with effective management is a critical success factor of agile transformation [S12].

4.2 Effects of the critical success factors (RQ2)

For the second research question, "*RQ2: What are the effects generated by the critical success factors related to an agile transformation from a project management perspective?*", it was possible to identify that the CSF related to the agile transformation from a project management perspective generate some effects in organizations that develop software. Table 3 lists the identified effects (E) and the relation between them and the critical success factors.

Commitment to Change (E01) is the most cited effect generated by the CSF. A total of 6 studies (S02, S03, S05, S06, S07 and S08) treated this effect as a result of 8 factors (F01, F02, F03, F05, F07,

Table 3: Identified effects and their relation with the critical success factors

ID	Effect	F01	F02	F03	F04	F05	F06	F07	F08	F09	F10	F11	F12
E01	Commitment to change	S02, S03, S07	S05	S05, S06		S07		S05	S06	S07	S08		
E02	Collaborative decision-making	S12	S05, S12	S12	S12	S11							S12
E03	Effective customers feedback	S12	S12	S12	S12						S08		S12
E04	Team collaboration	S07	S09			S07, S11				S07		S11	
E05	Agile culture construction	S02, S12	S12	S12	S12								S12
E06	Work control	S03, S12	S12	S12	S12								S12
E07	Self-organized teams	S12	S12	S12	S12								S12
E08	Customer satisfaction	S03, S10	S09								S08		
E09	Better communication	S12	S12	S12	S12								S12
E10	Team adaptability	S10	S04										
E11	Trust in people	S10									S08		
E12	Responsibility building						S01						
E13	Increased software quality	S03											
E14	Increased investment in projects	S03											
E15	Management support for teams	S02											
E16	Facilitate effort estimation	S03											
E17	Reduced delivery time	S03											

F08, F09 and F10). It is worth noting that F01 (Top Management Support) and F03 (Adapting the Process to Agile) are the most mentioned CSF, with 3 and 2 citations, respectively. Effects Collaborative Decision-Making (E02) and Effective Customers Feedback (E03) were generated from 6 CSF. Studies S05, S11, and S12 addressed Collaborative Decision-Making (E02) as an effect generated by the factors F01, F02, F03, F04, F05 and F12. Effective Customers Feedback (E03) was considered an effect of factors F01, F02, F03, F04, F10 and F12 according to studies S08 and S12.

Responsibility Building (E12) was considered by only 1 study (S01) as an effect resulting from only one CSF (F06). Similarly, Management Support for Teams (E15) is considered as an effect resulting from F01) by only 1 study (S02). In addition to E12 and E15, Increased Software Quality (E13), Increased Investment in Projects (E14), Facilitate Effort Estimation (E16) and Reduced Delivery Time (E17) were mentioned only by the study (S03) as effects resulting from Top Management Support (F01).

Team Collaboration (E04), Agile Culture Construction (E05), Work Control (E06), and Self-organized Teams (E07) were identified as effects generated from the CSF F01, F02, F03, F04, F05, F09, F11, and F12 by studies S02, S03, S07, S09, S11, and S12. In addition to Self-Organized Teams (E07), Customer Satisfaction (E08), Better Communication (E09), Team Adaptability (E10), and Trust in People (E11), they were also considered as effects generated by CSF F01, F02, F03, F04, F10, and F12.

4.3 Limitations and Threats to Validity

Although this study identified 12 CSF through an SMS, following the required methodological rigor, limitations are still possible. Limitations include the limited number of studies that dealt with the investigated management perspective and the need for more evaluation of the practical application of the identified CSF, although the selected studies referred to actual agile transformation initiatives. The evaluation of these CSF in real contexts can be performed in future studies.

We sought to maintain quality and rigor in all phases of this study. However, any investigation can have threats to the validity of its results. Therefore, these threats must receive careful treatment to not compromise the results achieved. Next, we discuss the main threats following the classification presented in [28].

Descriptive validity refers to how much the observations are objectively and precisely described. We treated it by using a data collection form to aid data extraction. Also, we defined and followed a strict protocol to describe our rationale, identify the source material, and extract and report the results.

Research questions approached superficially or with little detail can interfere with the understanding of researchers and contribute to the extraction of information in an inadequate way. Ad-hoc procedures to extract and refine data may impact results. Some defined data extraction steps may be subjective, and decisions depend on another reviewer. For this reason, authors R1 and R4 analyzed the data, which were reviewed by authors R2 and R3. For researchers' agreement, the Kappa [10] test was used.

In the search phase, studies may have yet to be found. In addition, there may be bias on the part of the researchers, from the identification phase of the studies to their final classification. For this reason, the researcher must be able to capture what has been defined. The search string was tested and revised before searching the digital database. The search string final version defined was the most comprehensive string tested. We also defined control papers to guarantee important papers were not to be missed.

Regarding the *generalizability threat*, the study can not be generalized to other contexts. In turn, for the *theoretical validity*, after discussion and agreement by the researchers on the inclusion and exclusion criteria, the studies were analysed following the defined protocol strictly. Still, there is a chance of bias by the researcher in data extraction and classification. Hence, revisions were made by two authors (R5 and R6) with experience running secondary studies. Also, we expanded the coverage of relevant studies by performing searches in four databases, including SCOPUS, which indexes other bases.

Finally, the last threat refers to *interpretative validity*, which is given by the coherent and reasonable interpretation of the results extracted from the data. We adopted a procedure to perform peer review and reach consensus on the extracted data and their interpretation to reduce the researchers' interpretative bias. Also, authors R5 e R6 supervised the protocol definition and the study execution and report.

5 DISCUSSION

Critical success factors (CSF) are the key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his goals [3]. Because these areas of activity are critical, the manager should have the appropriate information to allow him to determine whether events are proceeding sufficiently well in each area [3]. Regarding agile adoption, the CSF comprises the fundamental factors that must be present in the agile project to be successful [9]. Despite the importance and relevance of CSF to the success of the agile journey, few studies provide a list of CSF associated with the project management perspective. Thus, in this study, we sought to identify the CSF implicitly or explicitly related to this perspective.

The identified CSF have a significant relation with the profile and behavior of managers and people involved in software project management. They are critical to the success of an agile journey in various key areas of the agile transformation initiative that depend on management at more tactical and operational levels.

The critical success factors Top Management Support (F01), Team Empowerment (F02), and Adapting the Process to Agile (F03) are the most mentioned in the literature. These factors refer to aspects that depend on the role of the project manager as a link among the various stakeholders [34]. However, even though Top Management Support (F01) is mentioned in the studies and does not refer directly to project management, there is an interdependence between the strategic level (top management) and the tactical and operational levels (project management), which should be observed [34]. On the other hand, Team Accountability (F06), Team Personal Characteristics (F07), Experimentation of New Solutions (F08), Servant Leader Mindset (F09), Adoption of Participatory Management (F10), Good Communication (F11), and Building Strong Teams (F12) factors, although less cited, are equally dependent on the project manager's performance. In this sense, regardless of whether they are more or less cited, these CSF impact successful agile transformation.

In addition to the identified CSF, we also identified a set of 17 effects generated by the CSF related to the agile transformation from the project management perspective. Top Management Support (F01) is the factor that produces the highest number of effects (16). This result suggests that organizations that intend to undergo an agile transformation need top management committed to supporting the entire process and the teams, promoting empowerment (S07), especially in decision-making (S02), and creating an environment with conditions for occurring the changes (S07). Another issue observed is that the effects resulting from Top Management Support (F01) are very close to the tactical and operational levels of project management, such as the Facilitate effort estimation (E16) effect, which reinforces the top management support as part of more comprehensive management support [24].

On the other hand, Commitment to Change (E01) is the effect most referred to as consequence of the CSF at the most diverse levels of project management in organizations that develop software (F01, F02, F03, F05, F07, F08, F09 and F10). This suggests that the project management can benefit from a new mindset when leading projects from people involved in the management (S06) from more collaborative management (S05), besides creating better conditions for new changes to occur in the organizational environment (S07).

The nature of the main problems in software development is managerial and not technological. Project management plays an essential role in software development, as the proper application of knowledge, skills, tools, and techniques depends on it [29].

6 FINAL CONSIDERATIONS

Several barriers are imposed as organizations increase the use of agile methods and practices. Challenges, obstacles, and CSF permeate the change process in software development, especially regarding the project managers, who play a relevant role in software project management [16]. Personal, cultural, leadership and other characteristics associated with management exert significant influences before, during, and after the development of the agile transformation [24, 35]. Despite the importance of the profile and the role played by the manager, the studies do not explicitly provide visibility to the CSF associated with the project management perspective in agile transformations [24].

We executed an SMS to identify the CSF of agile transformation initiatives from a project management perspective to mitigate this gap. As a result, we identified 12 studies that answered the research questions and allowed us to improve our understanding of the matter. The most cited CSF are Top Management Support, Team Empowerment, and Adapting the Process to Agile. Among the least cited, but no less important, are those focused on Good Communication and Building Strong Teams. Commitment to Change, Collaborative Decision-Making and Effective Customer Feedback are also highlighted among the effects generated by the CSF.

The 12 CSF and the 17 effects identified can contribute to organizations that develop software to succeed in their agile transformation endeavor. Furthermore, the results presented can serve as a reference to project managers who wish to improve the performance and success of the agile adoption.

Significant changes that can affect the organization as a whole can arise from the inadequacy of the agile transformation process [18], mainly if we consider the organization as a complex, interrelated system composed of interdependent processes, people and activities [2, 31]. The transition from the traditional to the agile model, due to the unstable and fast-changing environment, deserves special attention [17, 18, 29], particularly because correct management can impact the success or failure of an agile transformation initiative [24, 35]. From this perspective, managers can assist in agile transformation and increase the chance of success.

In future work, we will conduct an opinion survey to evaluate the 12 critical success factors identified in this study, verifying their degree of relevance according to project managers in the context of agile transformation. Moreover, a catalog of CSF containing data, definitions, and mechanisms associated with agile transformation initiatives might be helpful to managers and other stakeholders involved in enabling such initiatives.

REFERENCES

[1] Abdalla Alhroub and Ayham AM Jaaron. 2019. Assessing agile project management practices: the case of Palestinian software development companies. *Middle East Journal of Management* 6, 1 (2019), 95–120.

[2] Ludwig von Bertalanffy. 1968. *General system theory: Foundations, development, applications.* G. Braziller.

[3] Christine V Bullen and John F Rockart. 1981. A primer on critical success factors. *Center for Information Systems Research Working Paper* (1981).

[4] Ruben Burga, Chris Spraakman, Carson Balestreri, and Davar Rezania. 2022. Examining the transition to agile practices with information technology projects: Agile teams and their experience of accountability. *International Journal of Project Management* 40, 1 (2022), 76–87.

[5] Victor R Basili1 Gianluigi Caldiera and H Dieter Rombach. 1994. The experience factory. *Encyclopedia of Software Eng.: Vol* 1 (1994), 469–476.

[6] Martin Calnan and Alon Rozen. 2019. ING's Agile transformation—Teaching an elephant to race. *Journal of Creating Value* 5, 2 (2019), 190–209.

[7] Amadeu Silveira Campanelli, Dairton Bassi, and Fernando Silva Parreiras. 2017. Agile transformation success factors: a practitioner's survey. In *International Conference on Advanced Information Systems Engineering.* Springer, 364–379.

[8] Amadeu Silveira Campanelli and Fernando Silva Parreiras. 2015. Agile methods tailoring–A systematic literature review. *Journal of Systems and Software* 110 (2015), 85–100.

[9] Tsun Chow and Dac-Buu Cao. 2008. A survey study of critical success factors in agile software projects. *Journal of systems and software* 81, 6 (2008), 961–971.

[10] Jacob Cohen. 1960. A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement* 20, 1 (1960), 37–46. https://doi.org/10.1177/001316446002000104 arXiv:https://doi.org/10.1177/001316446002000104

[11] Kieran Conboy, Sharon Coyle, Xiaofeng Wang, and Minna Pikkarainen. 2011. People over Process: Key Challenges in Agile Development. *IEEE Software* 28, 4 (2011), 48–57. https://doi.org/10.1109/MS.2010.132

[12] Digital.ai. 2021. 15th Annual State Of Agile Report | Resource Center | Digital.ai. https://digital.ai/resource-center/analyst-reports/state-of-agile-report/. (Accessed on 12/06/2022).

[13] Thaíssa Diirr and Gleison Santos. 2014. Improvement of IT service processes: a study of critical success factors. *Journal of Software engineering research and development* 2 (2014), 1–21.

[14] Kim Dikert, Maria Paasivaara, and Casper Lassenius. 2016. Challenges and success factors for large-scale agile transformations: A systematic literature review. *Journal of Systems and Software* 119 (2016), 87–108.

[15] Tore Dyba, Torgeir Dingsoyr, and Geir K Hanssen. 2007. Applying systematic reviews to diverse study types: An experience report. In *First international symposium on empirical software engineering and measurement (ESEM 2007).* IEEE, 225–234.

[16] Tore Dybå, Torgeir Dingsøyr, and Nils Brede Moe. 2014. Agile project management. In *Software project management in a changing world.* Springer, 277–300.

[17] Taghi Javdani Gandomani and Mina Ziaei Nafchi. 2015. An empirically-developed framework for Agile transition and adoption: A Grounded Theory approach. *Journal of Systems and Software* 107 (2015), 204–219.

[18] Taghi Javdani Gandomani, Hazura Zulzalil, Abdul Azim Abdul Ghani, Abu Bakar Md Sultan, and Mina Ziaei Nafchi. 2013. Obstacles in moving to agile software development methods; at a glance. *Journal of Computer Science* 9, 5 (2013), 620.

[19] Taghi Javdani Gandomani, Hazura Zulzalil, and Mina Ziaei Nafchi. 2014. Agile Transformation: What is it about?. In *2014 8th. Malaysian Software Engineering Conference (MySEC).* IEEE, 240–245.

[20] Anastasia Grass, Julia Backmann, and Martin Hoegl. 2020. From empowerment dynamics to team adaptability: exploring and conceptualizing the continuous agile team innovation process. *Journal of Product Innovation Management* 37, 4 (2020), 324–351.

[21] Miloš Jovanović, Antoni-Lluís Mesquida, Antonia Mas, and Ricardo Colomo-Palacios. 2020. Agile transition and adoption frameworks, issues and factors: a systematic mapping. *IEEE Access* 8 (2020), 15711–15735.

[22] Barbara Kitchenham, Stuart Charters, et al. 2007. Guidelines for performing systematic literature reviews in software engineering. *Keele University, Keele, UK.* (2007), 65.

[23] Leonardo Lourenco Lacerda and Felipe Furtado. 2018. Factors that help in the implantation of agile methods: A systematic mapping of the liteature. In *2018 13th Iberian Conference on Information Systems and Technologies (CISTI).* IEEE, 1–6.

[24] Alok Mishra, Samia Abdalhamid, Deepti Mishra, and Sofiya Ostrovska. 2021. Organizational issues in embracing Agile methods: an empirical assessment. *International Journal of System Assurance Engineering and Management* 12, 6 (2021), 1420–1433.

[25] Mariano Angel Montoni and Ana Regina Cavalcanti da Rocha. 2011. Uma investigação sobre os fatores críticos de sucesso em iniciativas de melhoria de processos de software [An investigation into the critical success factors in software process improvement initiatives]. In *Anais do X Simpósio Brasileiro de Qualidade de Software.* SBC, 151–165.

[26] Maria Paasivaara and Casper Lassenius. 2014. Communities of practice in a large distributed agile software development organization–Case Ericsson. *Information and Software Technology* 56, 12 (2014), 1556–1577.

[27] Matthew J Page, Joanne E McKenzie, Patrick M Bossuyt, Isabelle Boutron, Tammy C Hoffmann, Cynthia D Mulrow, Larissa Shamseer, Jennifer M Tetzlaff, Elie A Akl, Sue E Brennan, et al. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Systematic reviews* 10, 1 (2021), 1–11.

[28] Kai Petersen, Sairam Vakkalanka, and Ludwik Kuzniarz. 2015. Guidelines for conducting systematic mapping studies in software engineering: An update. *Information and software technology* 64 (2015), 1–18.

[29] GUIDE PMBOK. 2013. A Guide to the Project Management Body of Knowledge (PMBOK® Guide). *Fifth Edition* 123 (2013), 25.

[30] Fabio Reginaldo and Gleison Santos. 2020. Challenges in Agile Transformation Journey: A Qualitative Study. In *Proceedings of the 34th Brazilian Symposium on Software Engineering.* 11–20.

[31] Denis Alcides Rezende and Aline França de Abreu. 2009. Tecnologia da informação aplicada a sistemas de informação empresariais [Information technology applied to business information systems]. *São Paulo: Atlas* 3 (2009), 30.

[32] Daniel Russo. 2021. The Agile Success Model: A Mixed-methods Study of a Large-scale Agile Transformation. *ACM Transactions on Software Engineering and Methodology (TOSEM)* 30, 4 (2021), 1–46.

[33] Nancy L Russo, Guy Fitzgerald, and Siamak Shams. 2013. Exploring adoption and use of agile methods: A comparative case study. (2013).

[34] Yogeshwar Shastri, Rashina Hoda, and Robert Amor. 2017. Understanding the roles of the manager in agile project management. In *Proceedings of the 10th Innovations in Software Engineering Conference.* 45–55.

[35] Danielle RD Silva, André F Santana, Patrícia R Tedesco, Geber L Ramalho, and Hermano Perrelli. 2007. Um Retrato da Gestão de Pessoas em Projetos de Software: A Visão do Gerente vs. A do Desenvolvedor [A Portrait of People Management in Software Projects: The Manager's View vs. Developer's]. *XXI Simpósio Brasileiro de Engenharia de Software, João Pessoa* (2007).

[36] Jayakanth Srinivasan and Kristina Lundqvist. 2010. Agile in India: Challenges and lessons learned. In *Proceedings of the 3rd India software engineering conference.* 125–130.

[37] José Carlos de Toledo, Sérgio Luís da Silva, Glauco Henrique Souza Mendes, and Daniel Jugend. 2008. Fatores críticos de sucesso no gerenciamento de projetos de desenvolvimento de produto em empresas de base tecnológica de pequeno e médio porte [Critical success factors in managing product development projects in small and medium-sized technology-based companies]. *Gestão & Produção* 15 (2008), 117–134.

[38] Hany Wells, Darren Dalcher, and Hedley Smyth. 2015. The adoption of agile management practices in a traditional project environment: An IT/IS Case Study. In *2015 48th Hawaii international conference on system sciences.* IEEE, 4446–4453.

[39] Dave West, Tom Grant, Mary Gerush, and David D'Silva. 2010. Agile development: Mainstream adoption has changed agility. *Forrester Research* 2, 1 (2010), 41.