# Software Development Teams: Factors Influencing their Productivity

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Software development productivity has been widely studied in academia from different perspectives, including its meaning, measurement, dimensions, and how to improve it, at an individual, team, and organizational level. In the last decade, several factors have emerged that influence the way of working and thus, the productivity of agile development teams. These factors could be related to interactive, collaborative, and simplified work environments, among others. A better understanding of such factors and how they affect productivity could help organizations to determine how to deal with them when implementing agile practices and where to focus management efforts to have better results and deliver value faster. However, an insufficient empirical basis on this topic was found. This work shows an analysis of the state of the art regarding the factors that influence these teams, studying their impact on productivity, all this through a systematic literature review process. After analyzing results, it can be concluded that the factors that most affect team productivity are those related to the interaction between members, especially communication and distance, as well as the way in which they are organized. Those aspects related to the individual characteristics and soft skills are influential factors over the team performance. It is important to point out that even though the studies mention factors that affect productivity in different ways, they do not propose strategies for adapting agile practices, and only a couple of them propose practices that have a positive impact.

Keywords-- work teams, productivity, factors, agile.

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***Abstract*– Software development productivity has been widely studied in academia from different perspectives, including its meaning, measurement, dimensions, and how to improve it, at an individual, team, and organizational level. In the last decade, several factors have emerged that influence the way of working and thus, the productivity of agile development teams. These factors could be related to interactive, collaborative, and simplified work environments, among others. A better understanding of such factors and how they affect productivity could help organizations to determine how to deal with them when implementing agile practices and where to focus management efforts to have better results and deliver value faster. However, an insufficient empirical basis on this topic was found. This work shows an analysis of the state of the art regarding the factors that influence these teams, studying their impact on productivity, all this through a systematic literature review process. After analyzing results, it can be concluded that the factors that most affect team productivity are those related to the interaction between members, especially communication and distance, as well as the way in which they are organized. Those aspects related to the individual characteristics and soft skills are influential factors over the team performance. It is important to point out that even though the studies mention factors that affect productivity in different ways, they do not propose strategies for adapting agile practices, and only a couple of them propose practices that have a positive impact.***

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## I. Introduction

In the early 1990s, Peter Drucker [1] argued that the greatest challenge for managers was to increase productivity, where the key is to work smarter.

Since Agile practices' birth and the establishment of the agile manifesto [2], the goal has been to improve the way of working, which can be matched with Drucker's words. It concentrates on people and teams as the main elements of change. Among all agile practices, there are some that focus on people, one of the most popular is Management 3.0 [3], a discipline that brings together a set of ideas to empower people and their teams, with the aim of increasing their productivity, which in an agile context, prioritizes client satisfaction through fast and continuous value delivery that satisfies all stakeholders requirements [4]. The point provided by these management techniques, allowed moving from considering workers as simple resources to considering them as the key for a successful project [5], as well as the first-order non-linear component in the development of software [6].

**Digital Object Identifier:** (only for full papers, inserted by LACCEI).
**ISSN, ISBN:** (to be inserted by LACCEI).
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Several changes in the software development field took place in the last decade and must be considered since many factors have emerged, they influence the way of working and the productivity of development teams despite the development technique used. These factors could be related to interactive, collaborative and simplified work environments [7]; the coexistence of different generations in the same work environment [8], new technologies that propose a change in organizational culture to improve the way employees interact with each other and with the information; not to mention the effects caused by the COVID-19 pandemic (e.g. the work intensification, extending the workday in some cases [9]).

It is critical for organizations to understand which are the factors that influence productivity to see how agile practices, which are being widely adopted, should be implemented to increase its benefits and to reduce its negative impacts they could have; however, insufficient empirical basis was found. Related to this, a better understanding of the factors and how they affect productivity could help to determine where to focus management efforts to have better results and deliver value faster.

Considering all the above, this paper presents the state of the art of socio-cultural factors that influence the way agile development teams work, analyzing their impact on their productivity through a systematic literature review (SLR) process [10]. Even when there are other contributions and studies related to this work, the main difference is that this one focuses on factors that affect work teams, particularly, on software development teams.

It is worth clarifying the concepts of productivity and performance that will be used throughout this study. It is well known that authors like Tangen [11], Melo [12] and Wagner [13] propose definitions to this term, and often it is related to efficiency and effectiveness [14]. From a value-oriented point of view, maximizing productivity will be related to creating the highest value with the lowest resource usage. According to the first agile principle, the most important aspect is customer satisfaction through the early and continuous delivery of valuable software, satisfying the requirements from all stakeholders [4], being this the definition that will be used in this study. This term will be used interchangeably with the term performance.

The article is structured as follows: first, the method used to perform the analysis of the state of the art is detailed (III. Method section). Next, the results

OBTAINED FROM ITS APPLICATION ARE EXPOSED (IV. RESULTS SECTION). THEN, THE DISCUSSION IS PRESENTED, AND THE RESEARCH QUESTIONS ARE ANSWERED (V. DISCUSSION). FINALLY, CONCLUSIONS AND FUTURE WORK ARE PRESENTED.II. RELATED WORKS

## II. Related Works

In previous works, the state-of-art of elements such as factors, metrics, capability, motivators or demotivators that influence the software development field were studied in SLR processes, in individual or team perspective.

In [15], a research was conducted on major factors that influence software development productivity of European space, military and industrial applications and determined metrics for these kinds of projects. They mentioned the programming language used has an influence on productivity, and companies that undertook projects with low reliability requirements, low main storage constraints, low execution time constraints and high use of tools and modern programming practices had a higher productivity.

A SLR was conducted on factors that influence productivity in software engineering in [13]. They divided the ones found into technical and soft factors. A highlight on communication influence on productivity is mentioned, also business domain and developers experience.

A conceptual framework based on previous works was presented in [16], specifying factors that influence productivity, such as personnel rotation, team design, and coordination between teams.

In [17] an empirical study in a project managed with SCRUM was driven. They had a distributed team. The study focused on integration and test, leading to the conclusion that communication, expertise, and product quality from remote developers influence productivity.

In [18], a hypothetical model of factors influencing software teams was developed and three groups were studied: productivity, social productivity, and social capital. Finally, an examination of a turkey company is made, finding a strong relationship between the proposed constructs.

The study [19] identifies and analyzes factors influencing productivity in agile teams and performs a survey between 52 companies. The results suggest that most of the factors related to the team have a positive impact (role of the team and its leader, relationship inter-teams, team velocity, etc.) while tools such as leader meets, unit testing or regression testing have a negative influence.

In the works mentioned, even when the approaches could be like the one used in this study, they lack focus on factors influencing productivity in teams that apply different agile practices and techniques.

## III. Research Method

The method used to carry out this study is the SLR, proposed by [20] which is based on [10], whose main phases are planning, execution, and analysis of results. Parallel to the whole process, the information obtained is stored, and checkpoints are incorporated to validate each stage. This section presents the activities proposed for the planning stage.

### *A. Research Questions*

Firstly, the main objective of the SLR is defined: to determine which socio-cultural factors influence the productivity of agile software development teams. Starting from there, the research questions (RQ) are posed: **1) RQ1: What are the socio-cultural factors and their influence on the productivity of agile development teams?** According to [21] social factors are a set of elements that originate in society and can be grouped into sub-categories such as social structure (rules, relationships between members, etc.) or institution, and have a great impact on the individual and society in general. As for cultural factors, they are defined as elements that have their roots in the culture of a particular society, according to [22] culture "consists of a set of unwritten rules of the social game. It is the collective programming of the mind that distinguishes members of a group or category from others". Culture is learned and involves symbols, heroes, rituals, and values. According to [23], it can have a huge effect on how people interpret a given situation and how they react to it. Therefore, it can be said that socio-cultural factors mix both social and cultural phenomena that occur in a society involving both community organization and the meaning of community organization. This research focuses on aspects that influence the individual or the work team, like communication, trust, and motivation, among others [23], as well as factors related to organizational and national culture, individual motivations, and work ethics. **2) RQ2: How do agile practices adapt to the existence of these factors?** As mentioned in the 1. Introduction, many agile practices try to improve the way development teams work. These practices, for the most part, recommend techniques that depend on issues such as co-location or organizational culture, among others. In this sense, it seems important to know if alternatives to the operationalization of agile practices are proposed in the presence of factors influencing team productivity, or if there is evidence of successful adaptations of these practices.

### *B. Data source and query strings*

The data sources consulted in this paper are the following: IEEEXplore, SpringerLink, Science Direct, ACM Digital Library and Scopus. Since Google Scholar ingests data from different indexed journals and it can increase the number of duplicated articles, it was not included in this review.

Considering what was told in I. Introduction and the main objective of this study, the query string used was: agile AND "software development" AND team AND ((human OR social OR cultural) AND (factor OR aspect)) AND (productivity OR performance)

To reduce the results obtained, the occurrence of these words was restricted to the title and abstract. This was made by adjusting the query to the data source since each one has a different approach to accomplish this.

The words chosen helped to obtain general factors related to the productivity or performance of software development teams that apply agile. Results were expected to not be

restricted to certain factors, which will be the case if certain types of factors were added to the query string.

*C. Inclusion and Exclusion Criteria*

To increase the accuracy of the research, studies have been eliminated through the definition of inclusion and exclusion criteria, as recommended by [10]. The inclusion criteria proposed were: 1) Articles must be written in English, 2) Articles must have been published in conferences or journals, 3) Titles or abstracts should have at least 3 of the following words, either singular or plural: agile, software, development, human, social, cultural, factor, aspect, team, productivity, performance, and 4) Titles or abstracts should suggest that the study is related to productivity or factors affecting productivity in software development teams.

In addition, those that accomplish the following exclusion criteria were eliminated: 1) Articles whose main objective is to classify other ones or are systematic reviews in themselves, 2) Articles published in textbooks, 3) Articles catalogued as short papers or the ones that mention productivity and the factors that affect it, but that do not go deeper into their analysis, 4) Articles that name or consider productivity important but do not indicate which factors affect it, and 5) Articles that are restricted to the public for copyright reasons.

*D. Data extraction and analysis*

In the data extraction phase, all the information from the studies that will allow answering the research questions was collected [10]. First, fundamental information was collected to identify each of the studies: title, authors, and year of publication. In addition, to further analyze the selected studies, it was decided to extract the factors named in the article and the adjustments made to agile practices to the existence of these factors.

*E. Quality assessment*

Once the studies that fulfilled the inclusion criteria and were not excluded were selected, the quality of the search was checked. As proposed by [13] four questions were defined to assess the quality of each study and to compare them. The scoring scale used was: Yes = 1, Partially = 0.5, No = 0.

The verification questions were:

1. QA1: Is the objective of the study clearly stated? With this question, the assessment focuses on how easy to understand the goal of the study is for the authors. In other words, if the goal was debated between members to fully understand it.
2. QA2: Is the research process properly structured? With this question, the authors evaluate if the study has the conventional parts of a scientific study: introduction, method, result, etc.
3. QA3: Does it clearly identify the factors that influence software development productivity? With this question, how explicitly the factors related to productivity were defined, is evaluated. In other words, if the factors mentioned in the study are clearly related to productivity.
4. QA4: Does it analyse the impact of factors on the productivity of software development? Some studies could mention factors related to productivity but fail at explaining the consequences of the factor in productivity. With this question, how clear the affectation between the factors and productivity is evaluated.

## IV Results

In this section, the results obtained in the SLR following the previously detailed are exposed.

*A. Search and Primary Selection*

By executing the query in each data source (DS) with the corresponding search string adapted to the syntax of each engine; 1223 results were obtained by executing these queries. Only the first 100 results returned by each search engine were considered (for those that exceeded it), ordered by relevance, resulting in 484 articles following authors that apply the same guidelines [10], [13], [20]. This allows the authors to focus on those considered the most relevant for this review. Then, there were 50 duplicated studies discarded, resulting in 434 unduplicated studies.

Subsequently, of the remaining 434, 85 were selected, representing 19,59% of studies that accomplished the inclusion criteria and did not accomplish the exclusion criteria. The percentage was affected by those studies that mentioned factors but could not be associated with the productivity of agile development teams. Finally, the quality of the 85 studies was assessed, as set out in the next section.

*B. Quality Assessment Results*

For the quality assessment, it was decided to establish a quality threshold as an extra filter for the primary studies; those studies with a score below 75% were discarded. Of the 85 studies initially considered as primary, 35 (41,18% of the studies) were found to have a quality score above the established threshold. This is because in the studies, even though the factors affecting productivity are listed, not all of them mention what their impact on productivity is or the analysis of the impact is scarce.

TABLE 1
PRIMARY STUDIES

| Nº | Title | Authors | Year |
|---|---|---|---|
| [16] | Interpretative Case Studies on Agile Team Productivity and Management | D. Šmite *et al.* | 2013 |
| [19] | An Empirical Analysis of the Effect of Agile Teams on Software Productivity | J. Iqbal *et al.* | 2019 |
| [24] | An Empirical Study of Agile Testing in a Distributed Software Development Project | A. M. Qahtani | 2020 |
| [25] | Teamwork Quality and Team Success in Software Development: A Non-exact Replication Study | A. C. D. Batista *et al.* | 2020 |
| [26] | Employee Retention and Turnover in Global Software Development: Comparing In-house Offshoring and Offshore Outsourcing | J. M. Bass, *et al.* | 2018 |
| [27] | Does Latitude Hurt While Longitude Kills? Geographical and Temporal Separation in a Large-Scale Software Development Project | P. Wagstrom, *et al.* | 2014 |
| [28] | How Do Software Developers Experience Team Performance in Lean and Agile Environments? | F. Fagerholm, *et al.* | 2014 |
| [29] | The Influence of Agile Practices on Performance in Software Engineering Teams: A Subgroup Perspective | L. Przybilla, *et al.* | 2018 |
| [30] | Behavior-driven Dynamics in Agile Development: The Effect of Fast Feedback on Teams | F. Kortum, Jil *et al.* | 2019 |
| [31] | Configuring Global Software Teams: A Multi-company Analysis of Project Productivity, Quality, and Profits | N. Ramasubbu, *et al.* | 2011 |

| | | | |
|---|---|---|---|
| [32] | Psychological Safety and Norm Clarity in Software Engineering Teams | P. Lenberg,R. Feldt | 2018 |
| [33] | The Communication Patterns of Technical Leaders: Impact on Product Development Team Performance | Kate Ehrlich, Marcelo Cataldo | 2014 |
| [34] | Factors Influencing Productivity of Agile Software Development Teamwork: A Qualitative System Dynamics Approach | I. Fatema; K. Sakib | 2017 |
| [35] | What Do Agile Teams Find Important for Their Success? | H. Alahyari *et al.* | 2018 |
| [36] | Realising Individual and Team Capability in Agile Software Development: A Qualitative Investigation | E. Mendes *et al.* | 2018 |
| [37] | Factors That Influence Performance in Global Virtual Teams in Outsourced Software Development Projects | L. Rutz; M. Tanner | 2016 |
| [38] | Understanding Lack of Trust in Distributed Agile Teams: A Grounded Theory Study | S. Dorairaj; J. Noble; P. Malik | 2012 |
| [39] | Job Performance Through Knowledge Sharing Behavior in Global Software Development Organizations | R. Anwar; *et al.* | 2018 |
| [40] | Does Distribution Make Any Difference? Quantitative Comparison of Collocated and Globally Distributed Projects | A. Piri; T. Niinimaki | 2011 |
| [41] | Building A Theory of Job Rotation In Software Engineering From An Instrumental Case Study | R. E. S. Santos *et al.* | 2016 |
| [42] | What Predicts Software Developers' Productivity? | E. Murphy-Hill; *et al.* | 2021 |
| [43] | Towards an Explanatory Theory of Motivation in Software Engineering: A Qualitative Case Study of a Small Software Company | A. C. C. França; *et al.* | 2012 |
| [44] | Challenges and Strategies for Motivating Software Testing Personnel | Anca Deak, *et al.* | 2016 |
| [45] | The Influence of Technical Debt on Software Developer Morale | Terese Besker *et al.* | 2020 |
| [46] | Organizing Knowledge Workforce for Specified Iterative Software Development Tasks | Benjamin B.M. Shao *et al.* | 2014 |
| [47] | Communication Patterns of Kanban Teams and Their Impact On Iteration Performance And Quality | S. Shafiq *et al.* | 2019 |
| [48] | The Links Between Agile Practices, Interpersonal Conflict, And Perceived Productivity | L. Gren | 2017 |
| [49] | Team Performance in Software Development: Research Results Versus Agile Principles | T. Dingsoyr *et al.* | 2016 |
| [50] | How Human and Organizational Factors Influence Software Teams Productivity in Covid-19 Pandemic: A Brazilian Survey | C.I.M. Bezerra, *et al.* | 2020 |
| [51] | Software Project Managers' Perceptions of Productivity Factors: Findings from a Qualitative Study | E. Oliveira, T. Conte, *et al.* | 2016 |
| [52] | Social Capital as a Determinant Factor of Software Development Productivity: An Empirical Study Using Structural Equation Modeling | M. Yilmaz, R. O'Connor | 2012 |
| [53] | Teamwork Quality and Project Success in Software Development: A Survey of Agile Development Teams | Y. LindsjÃ‚g, *et al.* | 2016 |
| [54] | Gender and Tenure Diversity in Github Teams | B. Vasilescu *et al.* | 2015 |
| [55] | Successful Extreme Programming: Fidelity to the Methodology or Good Teamworking? | S. Wood *et al.* | 2013 |
| [56] | Performance Alignment Work: How Software Developers Experience the Continuous Adaptation of Team Performance in Lean and Agile Environments | F. Fagerholm, et al. | 2015 |

*C. Data extraction results*

The data extraction was carried out according to the "Quality assessment" section, each article exposed in Table 1 was analyzed, obtaining a set of specific factors that affect the productivity of the development teams as result.

It was convenient to group factors in different dimensions. Even when different approaches were studied [13], [34], the authors decided to choose the proposal made by [57] since it fitted better the goals for this study and the factors found, but some adjustments were made to represent the dimensions. Subsequently, the factors were classified into four dimensions (Table 2), based on the proposal of [57] to organize and synthesize the results in section V. Discussion. The criteria for this classification were as follows:

1. Organizational: it includes the factors related to objectives, policies, standards, processes, values, and culture, established, or promoted, explicitly or implicitly at the organizational level.
2. Team: it includes the factors linked to team management, capabilities, and interactions that occur within a team.
3. Individual: it includes the factors intrinsic to the person, such as their values, culture, technical skills, and soft skills.
4. Process: it includes the factors directly associated with the methods, processes, practices, techniques, and tools associated with software development in the context of a project.

Before factors were grouped as shown in Table 2, data were processed to make the factors' classification clear. The ones in column "Particular factors" were found as more atomic ones.

TABLE 2
SUMMARY OF DATA EXTRACTION

| Dimension | Article | Particular factor |
|---|---|---|
| Team | [24], [25], [27]–[29], [31], [33]–[41], [47], [50], [54], [56], [58] | Work Environment<br>Psychological safety<br>Interaction between team members<br>Communication<br>Distance between team members<br>Organization of the team<br>Equipment Capabilities<br>Technical debt |
| Individual | [35], [37], [44], [45], [47], [51], [52], [56] | Soft Skills<br>Technical Capabilities<br>Motivation |
| Organizational | [26], [28], [35], [36], [42]–[44], [49], [56] | Organizational Support<br>Team management<br>Personnel Management<br>Individual training management<br>Characteristics of leadership<br>Characteristics of the projects |
| Processes | [16], [24], [30], [35], [36], [43], [52], [53], [56], [58] | Quality<br>SW development methods<br>Techniques for the management of SW projects<br>SW project management |

To fill the dimensions, the authors analyzed each particular factor (section IV.A) according to the definition of the study it was taken from and chose the dimension that fitted better according to the definitions established

## V. Discussion

This section answers the research questions posed in section III.A Research questions, using the main results presented previously.

*A. What are the Socio-Cultural Factors and their Influence on the Productivity of Agile Development Teams?*

As shown in Table 2, to facilitate the description and understanding of the factors found, these were grouped into different dimensions: team, individual, organizational and process, according to III.C.

**Team Dimension**

As for the factors grouped within the team dimension, the work environment can be mentioned as one of the factors that influences productivity [28], [36], [51], [56], understanding it as a set of physical, social and technical factors that influence the physical and mental well-being of team members and that generates, among other things, the sense of belonging of team members, i.e., the feeling of identification with the team they represent [39], which makes everyone work towards the same goal. When bad physical conditions in the work environment exist, social relationships are not encouraged or unfair competition is promoted, a negative working environment is generated to the detriment of team productivity because its members spend their time trying to solve these problems instead of working to reach the objectives. This aspect is considered in agile frameworks such as Scrum, where the work environment factor is important since it is present in the values of the framework itself: respect between teammates and value the ideas and efforts made by each one, sincerity to the other ones and compromise of all of them. It is important to keep in mind that Scrum could improve this factor when it is needed.

Related to this, the lack of psychological safety hurts productivity [33]. When there is no psychological safety [59] teams do not benefit from the diversity of ideas, since no one dares to raise a discordant thought for the fear of appearing ignorant or incompetent, this creates uncompetitive teams and organizations, with few ideas, affecting their productivity [60]. It also influences the sense of vulnerability of team members [39] their psychological well-being [36] and job satisfaction [54]. According to [60], it is the responsibility of the team leaders and the organization to create a culture of psychological safety within the organization. This factor is promoted as an important one by different agile practices such as Scrum (in daily meetings and retrospectives) and Crystal Clear (in reflective improvement sessions). So, for teams where psychological safety is a factor to be improved, these practices should be considered and applied to each case.

Another aspect that influences the team's productivity is the way members relate to each other, the interaction between them, taking into account the amount of time they have been working together [25], [31], the balance in the contribution made by each of the team members [25] the prestige that exists between them [32] the differences they may have with each other [39] the motivation shared by the team [51], [53], [56], the effort put on the successful accomplishment of the tasks assigned to the team [25], the fact that its members share the mental models [50], i.e. the common knowledge that the members have, which will allow them to understand the tasks to be developed, the relationship between them, and to coordinate the actions and interactions necessary to carry them out. It is also essential to consider the way in which teams with members of different cultures interact, since it has been identified that difficulties can arise when they do not understand each other's culture [39], affecting not only the team's performance but also the trust that may exist between them, among other aspects. Agile practices like Scrum search for improvement in enhancing interaction between members, since the framework provides different types of meetings in which each has a purpose: to share statuses, problems, prioritize work, define what needs to be improved, among others. This allows to reinforce the relationship between team individuals, trust and gives spaces to share. So, even when the whole Scrum framework is not applied, the meetings required to improve productivity should be considered.

Related to this, the existence of subgroups [29] in work teams could be mentioned as an influential factor, considering that people tend to relate to others that are perceived like themselves, generating subgroups acting in opposition to others, leading to conflicts. On the other hand, in [47], the empowerment of the team is emphasized, where the organization provides maximum collaboration environments with tools that allow them to evolve, achieving a shared understanding [38], organizing the information in a way that all team members can understand it.

In articles, such as [35], [39], [53], [56] communication is mentioned as a significant factor in productivity. In software development teams, and especially in agile teams, communication is essential. In fact, the agile manifesto [2] already states the importance of communication between team members and with the rest of the individuals involved. Frameworks such as Extreme Programming (XP) with open and honest communication [61], Scrum with its proposal boards and meetings [62], Heart of Agile [63] which propose practices that settle on honest and direct communication within the team. Communication refers to communication among team members [25], [34], [36] as well as the one they have with customers [24], whether the communication is face to face through daily meetings [36] or remotely [51]. A factor profoundly related to communication is the distance between team members, either geographically [27], [31], [41] or temporally [31]. Authors such as [64] state that the "perception" of distance influences how team members communicate: the further away people think they physically are, the less likely they are to cooperate, decide to do so or be persuaded to do so, so mechanisms must be established to minimize the perception of these distances. According to [65] what is most efficient is to be all physically in front of a blackboard and suggests that "the team should be seated no further apart than the length of a school bus". As it was mentioned before, the different techniques Scrum provides were created taking into account colocalization, for example: daily meetings are conceived as stand-up meetings of 15 minutes. On XP it is radical that it proposes having the customer sit with developers to be available to answer questions and interact with the development team.

Related to this, in [51] the importance of assistance for remote work is highlighted, for example providing the necessary tools or infrastructure for communication. Not taking these elements into account has a negative influence on productivity.

A further aspect that impacts productivity is the way teams are organized, that is, the structure selected to achieve the established objectives, the individuals that integrate it, and

the interaction methods used. To avoid a negative impact on productivity it is important to establish rules of functioning and behavior [33], the objectives to be accomplished [38], and that all members including the project leaders [35], [56] work towards them [50]. The commitment of the manager is as important as that of the team members [36]. Management 3.0 was conceived to improve several aspects of the organization, being the way, they are organized one of them, auto organized teams and shared goals are focused. If the way teams are organized is a concern and it is affecting performance, the different tools provided by Management 3.0 should be carefully analyzed to apply them.

As previously mentioned, the geographic distribution of team members [31] could negatively impact productivity, especially when an imbalance in the number of members exists (e.g., most of them located in the same place could try to impose decisions that may be inconsistent with the requirements of those who are in smaller locations, who will feel ignored, decreasing the productivity of the projects [31]). This is deeply related to the size of the team [53], the coordination [25] and collaboration [36] among the team members, as well as their reorganizations [28], [56], i.e., their rotation with other teams members, can negatively affect the predictions that can be made about the performance; the existence of cohesion [66] among its members [38], i.e., the ability of the team to commit to common goals even though they are subject to different contexts, as well as the good integration among them, which facilitates the completion of tasks and that the problems are not recurrent when performing them [38].

When building teams, it is important to consider diversity, both in terms of competencies [37] and expertise [36], [58] as well as in gender [58]. This will allow having multifunctional teams, making possible the concept of continuous learning within the team [50]. It is necessary to keep in mind that the top management should promote the self-organizing teams [67] within the established environmental conditions, this can be linked to the importance of the team having the power of decision-making [56].

Finally, under this dimension, the influence of technical debt on team morale was included [46]. Technical debt should be understood as the total amount of "less than perfect" design and execution decisions that occur in a project, which hinder the maintenance process or modifications to be made on the code, consequently affecting the productivity of the team [68].

**Individual Dimension**

Intrinsic factors such as values, culture, technical skills, and soft skills are taken into account. One of the most prominent aspects is the technical ability of each team member [37]. This is understood as the previous formal education, the knowledge of the application domain, and the quality of individual delivery, which can affect the performance of software development and the success of the project. In addition, the accurate estimation of individual effort, experience, and skills must be considered. Related to this, in [19] it is suggested that having technically skilled people allows having better administrative control of the project, which results in better performance. About this, skills and knowledge that enable individuals to carry out the tasks to be performed (i.e., the technical skills and capabilities [62] that everyone has) affect the productivity of the team [19]. The technical capability impacts, and it is particularly evident, in the effectiveness and efficiency that individuals have when performing tasks [54], as well as in the behavior they present when they are under time pressure [37], [45].

In this sense, it is possible to talk about the soft skills mentioned in [56] where it is indicated that the control of one's work is a performance facilitator. On the other hand, in [35] adaptability and self-management are positively mentioned in agile development, although mediated by good management, and it is indicated that individual motivation can also influence productivity. At [44] they study the theory of motivation and how it relates to contextual factors in a company, pointing out that the major drivers of motivation are the needs for growth and learning, along with self-efficacy, i.e., the ability to achieve the goals set, and that this leads to a greater commitment to it, which ultimately impacts in the performance. In [37] aspects such as behavior and initiative of the person are mentioned, furthermore, [45] points out that the lack of recognition of the individual, such as boredom, affects, above all, the personnel who carry out the tests.

As mentioned before, Management 3.0 is a leadership model based on motivation, empowerment, and shared responsibility. All the techniques involved in it try to improve not only the management itself, but the soft skills involved in a project, the way people feel, and the motivation they had, among others.

**Organizational dimension**

In this dimension, various factors were grouped, among them, those related to organizational support [28] which can be defined as the contribution that the individual makes to the organization and the recognition received from it [69] and can also be defined as the individual's perception of the organization [70]. In [36], some aspects linked to organizational support that affect the productivity of the teams were found, such as the strong executive support, and that agility is part of the culture of the organization, which implies a knowledge of agile processes by managers. It is also mentioned as aspects to consider: the cooperation of the organization preferably over a hierarchical one, and its transparency. In addition, it is considered as an influential aspect fostering a good working environment within the organization [28], [56], providing the necessary tools to generate a good working environment allowing to increase the productivity of the team.

When it comes to organizational support, Scrum can help to boost positively since it is meant to improve project management but also, something worth mentioning, is that retrospectives can help to spot aspects that need to be fixed and pay special attention to.

It should also be considered the way teams are managed at an organizational level, covering aspects that include the balance of established objectives, both inside and outside teams [56], as well as the competition that takes place between

members of a team [28]. The organization must also favor inter-team coordination as it impacts agile productivity [28] due to the different dependencies that may exist between teams [49] in a project, e.g., shared resources, the simultaneity of restrictions in the completion of tasks, etc., therefore the coordination of processes to manage dependencies among tasks allows the work between members of different teams. Apart from it, it is mentioned as an influential factor the design that the company chooses for these teams, both the assignment of tasks to its members, as well as the structure of them. The facility with the agile style of work that is possessed in the company [36] is also mentioned as an element to consider.

Regarding the structure and management of teams, there are many theories, from the one proposed by Taylor [71] where the organization is divided between people who think and people who do, to more recent ones such as Management 3.0 mentioned before, where people are the most important asset in an organization [3].

An important and strongest factor linked to team management is the personnel management carried out by the organization, elements such as personnel rotation [26], [49] both internal and external, since this is related to the change due to the arrival or departure of team members, is normally perceived as a negative influence on productivity. That is why staffing [35] i.e., selecting the person with the right skills and the necessary knowledge, becomes an important activity within personnel management.

Within this area, it is worth highlighting the support provided by the organization to the individual training of its members through skills training [35], career opportunities [44], having different approaches that allow the promotion of individuals and teams [56], and rewards according to agility [36]. In addition, productivity is influenced by the fact that employees can improve, that they count on the support of their peers when presenting new ideas [43], and the existence of mechanisms to share knowledge with the organization [36].

In the organizational dimension, it is important to implement adaptive management for the organization's projects [36], especially in environments of high uncertainty where changes based on the results obtained become necessary.

Finally, it was identified that the different characteristics of the organization's projects [36] and the management style have a great influence on the team's productivity. Aspects related to the presence of a variety of tasks and innovation [35], the existence of few external dependencies [36], or external factors [35] to the development team are mentioned. The type of relationship that is generated from the organization to the client also influences the team's productivity [36], as well as following the practices offered by the agility within the projects positively affects productivity, being this a decision that should be supported by the organization.

**Process Dimension**

Comprise factors such as the characteristics of the artifacts, e.g., in [36], several factors and metrics found in the literature are validated, through a series of interviews, including high-quality code and architecture, adequate amount of documentation, and high testability of the codebase, although they conclude that most of the factors are linked to the team and its environment. In [52], the perception of productivity is studied from the point of view of the managers, who focus mainly on the deliverables resulting from the developer's tasks and how well developed the produced artifacts are (those that do not need rework).

Regarding the practices or methods, in [56] it is studied whether the success of XP is due to its strict application or in fact to teamwork, they found that these variables affect jointly and that it is convenient to follow XP practices as faithfully as possible, even if some of its elements have a negative impact, as in the case of customer planning. Meanwhile, [16] mentioned that the agile practices of planning each iteration and iterative development are perceived by developers as beneficial for productivity, while continuous integration and testing are not. In contrast, in [24] through a case study, they reveal the positive impact of customer involvement in agile testing in the context of distributed teams. And in [36] they confirm the relevance of delivering the most important features first.

Under the factor of techniques for management of software projects, in [30], [43], and [52] the importance of feedback for productivity is highlighted. The first is from the point of view of immediacy through a tool, the second through the reception of useful feedback from peers, and the third one from the point of view of the manager to identify the developer's productivity. It is worth remembering that Scrum is a framework where all the techniques seek to improve management, so it should be considered in those scenarios. In [36] a validation of the importance of strong communication with daily face-to-face meetings is carried out. In it, it is also discovered, through interviews, that the definition of goals per sprint and well-defined user stories are considered success factors in projects; in this sense, in [47] they have also identified that requirements in the form of user stories increase productivity, as well as the joint elaboration of test cases.

So, XP can help to improve productivity, maximizing the benefits that come from these factors since its principles are related to rapid feedback, quality work, and embracing changes, among others. The techniques related to it are test-driven development, simple design, refactoring, following coding standards, etc. So, if these factors must be controlled with a certain practice to improve productivity, XP should be considered. Also, Crystal Clear proposes properties like a technical environment with similar practices to XP (automated tests, configuration management, and frequent integration), searching to continuously integrate with tests. If the performance is being damaged by the technical capabilities of the team members, practices suggested by these two should be studied deeper to pick the one that is right for the team.

Finally, for the management of SW projects, 19 influencing factors were detected through the System Dynamics methodology [35], three belong to this group, i.e., project management, objectives, and team orientation. As

mentioned before, techniques and practices present in Scrum search to improve and increase the benefits from these factors. Crystal Clear could help to improve these factors as well since it's a framework with a couple of practices that focus on project management. Also, techniques from XP could help too. On the other hand, in [52] they analyze productivity indicators from the project manager's perspective, including tasks delivered on time and outputs that meet stakeholder expectations. At [48] they study the effects of communication patterns linked to performance and quality in agile practices, specifically the centralized pattern and the small-world pattern in Kanban, finding that the former has a negative effect and the latter a positive one. Unlike other studies, in [58], authors based their work on open-source projects published on GitHub, analyzing the incidence of tenure in each project, both in productivity and project turnover, concluding that the inclusion of diverse experiences in the team is beneficial for the mentioned variables.

With a more general approach to development methodologies, in [19], a model is proposed based on two factors related to team building, the workload per developer ratio and the focus on quality over productivity and its influence on performance, the results indicate the convenience of increasing the tasks assigned to each developer to a certain extent and to focus on quality to increase productivity. In [53], they propose a model for analyzing social capital and productivity that involves, among others, process, reusability, and project complexity.

*B. How do Agile Practices Adapt to the Existence of these Factors?*

Regarding the adaptation of agile practices and the factors identified, most of the analyzed articles do not propose adaptation strategies but as mentioned, they focus on the identification of factors, how they affect the work teams, and the importance of considering it in both, organizations and individuals that are part of the work teams, according to the factor. Even in articles such as [16], [24], [28]–[30], [35]–[37], [39], [47], [49], [50], [54], [56] where they mention agility in the development process of the analyzed teams, no adaptations are specified, they only analyze how these factors affect the respective practice.

However, it should be noted that in [24] the importance of involving the client in the testing process is highlighted, as the teams that did so significantly increased their productivity, noting that this is due to the client's availability to discuss the test cases, as well as to debate on the results produced, which led to a fast verification process. Furthermore, in [33] it is proposed to add to SCRUM practices the possibility of obtaining early feedback more frequently, which is supported by a JIRA plug-in developed for this purpose, although with slightly positive results.

These results may occur as adaptations or modifications to practices take place daily in business and they are formalized into blog posts or related platforms, where the community can interact and share experiences.

Likewise, the COVID-19 pandemic has affected different aspects in companies from different fields and software has not been the exception. Factors such as communication, distance, social interaction between members, among others, are factors influenced by this issue [9], [50], [72].

## VI. Conclusions

This paper presents an analysis of the state of the art carried out through a systematic literature review process, including the factors that influence the way development teams work, analyzing the impact on the productivity of these teams.

As can be corroborated in section V.Discussion, from the analysis it can be concluded that the factors that most affect team productivity are those related to the interaction between team members, especially communication and distance, as well as the way in which they are organized, the poor management of these factors has a probable negative impact on productivity.

Those aspects related to the individual characteristics and soft skills that each team member possesses must be considered, since it is an influential aspect in the performance of the team in general. From another perspective, those aspects that can be established and controlled by the organization also have a great influence, such as the personnel management carried out by the organization, the characteristics of the projects that are adopted, the management of the teams that carry them out as well as the support given to them. Finally, elements linked to the software development process, such as a good architecture, the adequate amount of documentation, or the software development method implemented, are elements that affect productivity.

It is important to point out that even though the studies mention factors that affect productivity in different ways, they do not propose strategies for adapting agile practices, and only a couple of them propose practices that have a positive impact. As mentioned in the section IV Results, adaptations are often shared on blog posts or related platforms, such sources were not consulted in this study, as explained in the limitations.

As future work, an analysis will be carried out to obtain a set of strategies to adapt the frameworks used in software development, to increase the productivity of work team. In addition, an analysis of the state of the practice of software development companies is proposed to compare the results found by this study.

## Acknowledgment

This work was funded by CONICET and Universidad Tecnológica Nacional. Support provided by these institutions is appreciated.

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