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Defining Teamwork Productivity Factors in Agile Software Development

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***Abstract*—Teamwork productivity plays a substantial role in attaining successful projects in agile software development. For improving agile software development, it is necessary to look at many factors that influence agile teamwork productivity. Thus, there is a need to identify these influential ones among factors. Identifying these influential factors affecting agile teamwork productivity can enable the teams to pertain to where they need to enforce the elbow grease to improve productivity. Teams in software organizations will improve their productivity by considering these teamwork factors in agile software development. In this respect, the classification of the teamwork factors that might cause an influence on the productivity of the agile software development teams becomes the indication of divergence for the choice and characterization of enhancement approaches. We carried on a systematic literature review to execute such analysis in which we included 53 primary studies. The systematic literature review aimed to identify and classify the factors influencing teamwork productivity in agile software development. As a result of the systematic literature review, we identified 77 influential factors and classified these factors into technical, non-technical, organizational, environmental, project management, and user requirements level factors that affect teamwork productivity in agile software development. Based on this data, software organizations can mend the teamwork productivity of their teams by appraising the impact factors that best fit their context.**

***Keywords*— Software organizations; software development teams; teamwork factors; teamwork productivity; software companies.**

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I. INTRODUCTION

Most software companies are now adopting agile methodologies for their software development because it is one of the most effective and efficient development techniques in terms of time, cost, and coordination with the clients [1]. Agile software development (ASD) focuses more focusing on people-related factors in the project. Therefore, agile teamwork productivity (TWP) is an essential concern to achieve successful projects. To improve ASD and achieve successful projects, software companies need to consider a number of factors that affect agile TWP. Thus, organizations adopt ASD for increasing TWP, as it facilitates frequent delivery of working software [2]. In ASD, TWP is highly relevant in the context of successful projects [3]–[11]. TWP defines the performance of the overall project in an ASD process; hence, it is of substantial concern to study it. As agile teams are self-managed, therefore, team members should be aware of TWP factors [5]. TWP is a multi-dimensional idea that serves as an important indicator for a successful project. Software teams must consider the TWP to confirm the success of software development projects. This study aims to explore and recognize the main influential TWP factors that impact ASD. The results of this study are based on preceding studies to identify the TWP factors and to reach the classification of TWP factors in ASD. According to Gilal *et al*. [12], it is very important to select an appropriate classification technique for developing effective teamwork and TWP factors [13], [14]. Most software companies adopted ASD to improve productivity and deliver efficient software in a short period and with less cost [15]. In the perspective of ASD [15], the agile manifesto emphasizes individual and interactions among people (teamwork) factors over procedures and tools [16], [17]. Therefore, agile TWP plays an important role in achieving successful projects. For improving ASD, it is essential to consider the enormous number of factors that influencing agile TWP. Therefore, there is a need to identify these influential ones among the factors [5]. Identifying these influential factors influencing agile TWP can empower the teams to pertain to where they need to apply the effort to

improve productivity. The identified categories will help researchers provide better solutions in the development of software and will ultimately the researchers will provide new solutions for their specific software development. This gives us the motivation to assess the TWP factors identified in the literature. A recent study was conducted to approach the classification for social and human factors (SHF) that may impact productivity in software development team using SLR processes [18]. Hence, in this study, we carried out the Systematic Literature Review (SLR) that presents the outcomes that prevailed from 53 primary studies selected, identifying the factors and classifying the factors of influence found in technical, non-technical, organizational, environmental, project management, and requirements level factors [19]–[23].

Agile manifesto focuses on finest design, requirements, and project materializes from self-organizing teams; face-to-face communication; and the people involved who worked collectively on a daily basis [17]. In this study, we have included those studies which were focused on factors that impact the TWP. Thus, for the purpose of identification and of the proposed classification of TWP factors, these studies are used as the main input for the said purpose [8], [24], [25]. Nevertheless, this study also used other studies focusing on the different aspects of the ASD team, which were previously selected from the original primary studies and SLR's. For instance, there are some studies, including tertiary review, systematic mapping studies, which focused on factors that influence TWP [4], [26], [27]. These studies are recently published in 2017 – 2020, which establishes the latest literature review on the topic. According to Oliveira *et al.* [26], a common classification of productivity factors does not exist; otherwise, it suggests categorizing factors as organizational and human factors.

Similarly, the productivity factors [27] were presented as social and human factors for software development teams. However, all these studies talked about the factors that impact productivity in agile teams but only focus on factors identification and producing proposals for improving productivity. These studies also presented various methods for factors classification, which TWP are not considered explicitly. These studies do not consider environmental, requirements handling, project management factors, technical factors, and non-technical factors in detail.

Several studies conducted to analyze the effect of various influencing factors on agile TWP. Many surveys were led to an agile development process and practices [9], [28], [29]. However, there was not much about the TWP factors and their interrelationship. Only Melo and Israt assess the main factors influencing agile TWP [5], [9], [30]. The most influential factors are influencing TWP using the system dynamics methodology [5]. In this study, the author identified the most influential factors were included team effectiveness, team management, motivation, and customer satisfaction. A survey in 52 different software organizations was subject to evaluate the influence of teamwork factors on productivity in ASD [24]. The author suggested the most influential factors were included communication, team leadership, requirements stability, vision, speed, inter-team relationship, and other factors such as a team member and the role of a leader. Dzulaiha *et al.* [31] identified the most important characteristics necessary to be considered for forming a team and producing rational teamwork [32]. Self-selecting teams in ASD are important to coordinate the skills by improving the dependencies between the members of the agile teams [33].

It is hard to assess the effect of individual productivity on other team members [9]. Therefore, this motivation gives the insight to study TWP, not individual. Several studies have been conducted on teamwork in ASD on different topics such as team structure [2], task-related factors [34], motivation [35], and team vision [24]. There are some studies related to team performance in ASD to assess teamwork. A team performance referred to the assessment of the effects of TWP [2], [5]. A team performance model is used to describe the teamwork in a project implementing Scrum [36], [37]. TWP factors were identified and analyzed using 'Input Process Output' model in a multiple case study [30]. A learning management model for computer science students was proposed to promote teamwork and better understand the concept of ASD [38]. In another study, the author suggested that non-technical factors strongly correlate with teamwork productivity [39].

Nevertheless, several studies described the factors that impact productivity but merely focused on identifying the factors and getting recommendations for increasing TWP [27]. Therefore, these works demonstrate a deficiency of techniques that can be easily implemented to address these factors that obstruct TWP [27], [40]. Moreover, the productivity can be increased by reducing the costs; the software organizations must choose and devise the practices based on its main influencing TWP factors [5], [41]; at the same time, suitable techniques are needed to implement. Therefore, the SLR is carried out in this study to identify TWP factors and their classification aimed at improving the productivity of the ASD team is a necessary input for making concrete and conclusive development approaches and actions for TWP.

The existing studies are mostly focused on technical and non-technical factors, while this study identified other factors related to organizational, environmental, project management, and requirements level factors in improving teamwork productivity in agile software development. Therefore, this study concentrates on identifying and classifying the teamwork productivity factors that influence the productivity in ASD. Identifying these factors may help software organizations to reduce software project management issues, reduce development time, reduce product costs, and finally improve teamwork productivity.

This study contributes as follows:

- What are the factors that influence the teamwork productivity (TWP) in agile software development (ASD)?
- Which factors may be classified as teamwork productivity (TWP) factors in agile software development (ASD)?

The rest of the paper is arranged as follows. Section 2 presents the materials and methods. Section 3 presents the results of the research questions proposed and discussions for this study. Our conclusions and future work are presented in Section 4.

II. Materials and Methods

A SLR protocol is employed to survey the research articles from the utmost reliable sources in this work. The primary role of SLR is to back up the findings, interpretation, and evaluation of those research outcomes which are responding to the articulated research questions. The main purpose of finding the answers to these questions is that the existing studies do not provide a comprehensive report on the existing TWP in ASD. The proposed research will provide a comprehensive report through which researchers and practitioners will provide new solutions based on the existing evidence from this report. We have done both automatic and manual searches in different libraries to receive the required research results from elementary studies. The study considered mainly the impact of TWP factors in ASD. The quality assessment has been executed to analyze the subject field to get the best-fit solutions.

This study follows the SLR to answer the concerned queries, because it is very important to have a predefined protocol, which can reduce any research bias [42]. SLR in any specific field is a complete reappraisal of the comprised studies, which are mainly focused on keying out the cracks in prevailing research to further explore and furnish the new phenomena in a well-understood manner [43]. The SLR protocol followed in this study was based upon [43]. Fig. 1 shows the steps followed for this study as per the rules from Kitchenham's SLR [43]. The first step describes the review protocol. The second step is to limit the search strategy by following the documentation of the research strategies in the third step. Similarly, the fourth section describes the Inclusion and exclusion criteria to identify the research studies, while the fifth part defined the quality criteria assessment. The final part of this composition presents the quantitative meta-analysis of this report.

Fig. 1 Features of the systematic literature review [42]

Fig. 2 presents a flowchart of the methodology that shows the whole process of SLR followed for this study. The figure shows the process of searching the keywords in the given libraries with the search results obtained. The filtering process of papers by title, abstract, and finally contents is also shown in the figure. The figure is initially based on the research questions defined and then the search process in the given libraries using Boolean operators "AND". The search strategy is applied for resources and keywords search. The required articles are selected based on inclusion and exclusion criteria. The protocol is designed on the guidelines presented in Kitchenham [42]. The protocol for this study is briefly explained as follows:

A. Defining Review Protocol

The SLR was anticipated to comprehend and evaluate the investigational evidence concerning this study. This study focuses on articulating the questions proposed for this study, which will provide the preliminary start for additional exploration. The TWP in ASD is a complicated perception that is classified as a sign of project success [5]. For software development teams, TWP is a demanding facet that needs to be investigated to assure software development success.

TWP consists of different factors [5], which are interested in studying. Therefore, SLR protocol designed for this study primarily focuses on formulating such questions that might answer that what factors may influence the TWP in ASD. Table I shows the questions designed for this study, indicating how TWP factors contribute towards the software teams in ASD.

TABLE I
Research Questions

Research Questions	Description and Motivation
RQ1: Which factors influence the TWP in ASD?	The RQ1 focuses on TWP factors in ASD.
RQ2: Which factors may be classified as teamwork productivity factors in ASD?	The RQ2 aims to identify TWP factors classification based on considered studies and the selection of prospective factors in terms of the proposed study

B. Defining Search Strategy

In this step, manual and automatic searches are performed to fetch the utmost pertinent results. Initially, we started our research strategy by an automatic search implemented in the electronic databases and proved by professionals in the area of ASD, in the software organizations, and TWP. The databases accessed for this study include ACM, IEEE, Taylors and Francis, Wiley Online Library, Science Direct, and Other (including conference and journal papers except for these reputed libraries). These databases were selected because it includes the best collection of journals and conferences proceedings. The search was conducted from 2011 to 2020. The digital searches were chosen based on prior studies and suggestions, which are conducted and provided by other researchers [19], [44], [45], [46]. The keywords for this study were extracted based on research questions and from other alternatives available in the literature.

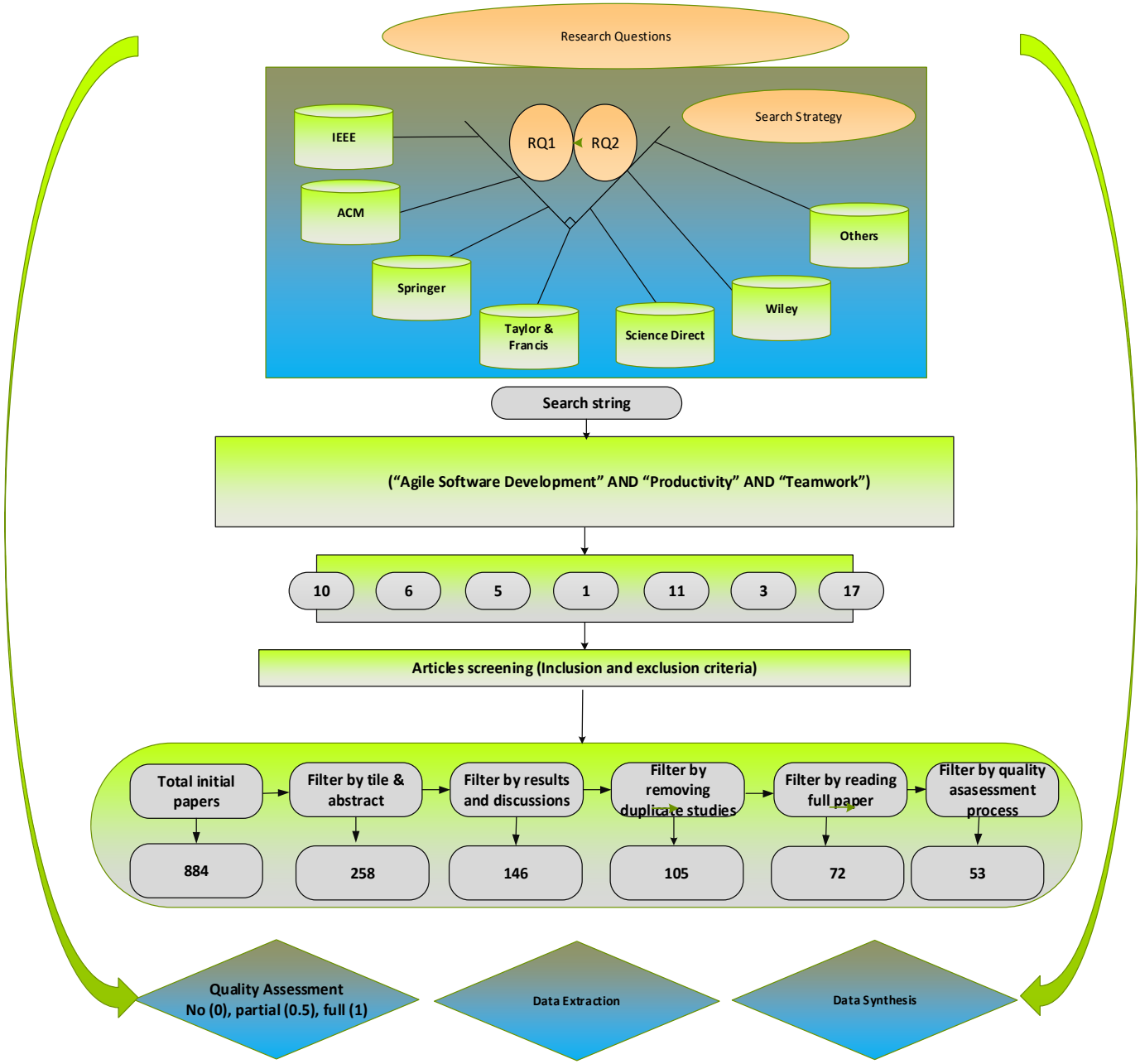

Fig. 2 Protocol Process and Libraries

The core keywords were concatenated by using the Boolean AND operator and their substitutes for the purpose of developing the search strings. The string used for searching was ("Agile Software Development" AND "Productivity" AND "Teamwork"). The search process was applied through the databases by identifying keywords based on research questions. The search was conducted using alternative and synonyms by verifying keywords in the relevant papers. The databases selected for this study are recommended databases used for research [47], and we concluded that this might cover most of the searches to attain our aims of research questions and from other alternatives available in the literature. The core keywords were concatenated by using the Boolean AND operator and their substitutes for the purpose of developing the search strings. The string used for searching was ("Agile Software Development" AND "Productivity" AND "Teamwork"). The search process was applied through the databases by identifying keywords based on research questions. The search was conducted using alternative and synonyms by verifying keywords in the relevant papers. The databases selected for this study are recommended databases used for research [47], and we concluded that this might cover most of the searches to attain our aims.

C. Documenting the Search Strategy

This step of the protocol was used to record all the documentation for the search strategies. After conducting this step, a document was achieved, which contained all the information about the search strategy. This document has included all the contents such as search date, name of the online library used, search strategies, source types, number of retrieved results, filtered, keywords name, and their groupings. A report was created to document the records of the search results.

D. Criteria for Inclusion and Exclusion

The selection (inclusion and exclusion) process were executed after conducting the search process to select the deemed relevant studies, which allows us to solve the questions for this study. Table II shows the criteria defined for inclusion and exclusion and applied to choose studies of concern. In Table III, the professionals are researchers; based on the peer-reviewed and published papers, the scholars and researchers were considered as professionals.

TABLE II
CRITERIA FOR INCLUSION AND EXCLUSION

Inclusion Criteria (all required for inclusion)	Exclusion Criteria (each sufficient for exclusion)
1. Studies pertained to TWP in ASD	1. Studies related to technical reports and discussion papers (not research papers) are excluded.
2. Studies performed in the range of 2011 and 2020.	2. Studies that were reproduced.
2. Studies described in the English language.	3. Studies related to the students' work only.
3. Professionals did studies.	4. Studies not related to teamwork, productivity and ASD.
4. Studies which were performed as primary studies.	

Based on the mentioned libraries, it is presented that these are the most popular and well-known libraries that are publishing quality research. For the conduction of the proposed study, these libraries were selected as they only publish quality research. Most of them cover these research questions defined for the proposed study.

TABLE III
SELECTION STRATEGY

Steps	Description	Applied Inclusion Criteria	Applied Exclusion criteria
0	Search for studies in the selected databases on the basis of the search string. The constraints for search include: the publish studies conducted in the range of 2011 and January 2020 and studies not defined in the English language.	2 and 3	
1	Studied the title and abstract of the selected studies and the inclusion and exclusion strategy was applied	1, 4 and 5	1, 3 and 4
2	Studied the results and abstract of the selected studies and the inclusion and exclusion strategy was applied	1 and 4	1 and 4
3	Duplicated studies were removed.		
4	Studied the full papers and inclusion and exclusion strategy was applied	1 and 4	1, 3 and 4

Our work is only limited to the mentioned libraries, and the search process is not generic, so only those materials were considered which were relevant. These materials were in the form of conferences, and journals were considered. During this selection process, the relevant selected studies were included. Table III shows the selection strategy; the abstract has been studied as shown in steps 1 and step 2 because the abstract is the paper's summarized form, which shows a detailed description of the whole paper.

E. Criteria for Quality Assessment

In this step, all the collected data were analyzed on the basis of consistency and relevancy to address the questions defined in this research. To achieve the required objective, the contents of each paper has been analyzed on the basis of exhaustive studies, the scores ("1" and "0.5") were assigned to each study. We interpret these values as "1" for high relevancy, "0.5" for medium relevancy and "0" for the paper which is not more relevant but was identified during the search process. These values are assigned to each selected paper for this research against the research questions RQ-1, RQ-2, as shown in the "Quality Assessment (QA)" column in Table IV. The quality score 0.5 was given for papers that partially talk about the research questions and 1 for papers that talk fully about the research question.

F. Quantitative Meta-Analysis

It is the last step of this protocol in which we have performed some statistical analysis on quantitative data. The literature also highly recommends that the quantitative meta-analysis establishes a quality research criteria for inclusion decisions [48]. Fig. 2 shows the results collected from the selected libraries on the basis of inclusion and exclusion criteria.

III. RESULTS AND DISCUSSIONS

In this section, we analyzed and categorized 53 primary studies that were comprised in the selected studies from different sources. We have presented the outcomes, which were achieved for the proposed study on the basis of two research questions. Initially, to achieve the outcome of the first question, we have presented and reported the TWP factors based on extraction from each primary study. For the second research question, we demonstrate and analyze the classification adopted by the selected studies [26], [27]. The identified factors and its classification are also described in this section.

Table IV shows the summary of the recent existing techniques available for identifying teamwork productivity. Furthermore, the quantitative analysis of multiple sources, including journals and conferences, was summarized in the questions proposed for this research. Then, the data were analyzed using statistical techniques such as mean and standard deviation to get more insight into the research questions and development. The developments in ASD based on the provision of TWP have been presented. Fig. 3 shows the dispersion of research sources identified for this study. Similarly, Fig. 4 presents the paper's distribution comprises based on publication year and the document type. The total selected papers from the conference and journals from each database have shown in Fig 5.

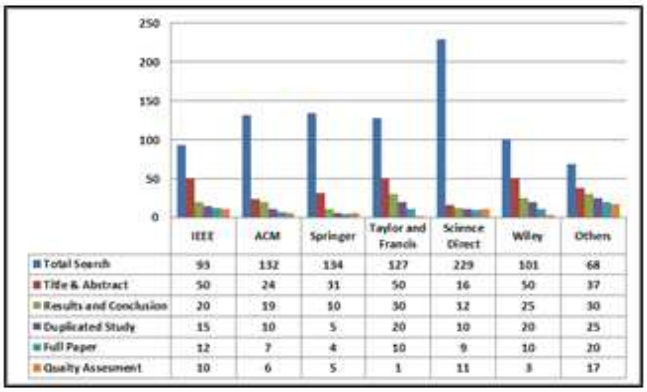

Fig. 3 Source distribution

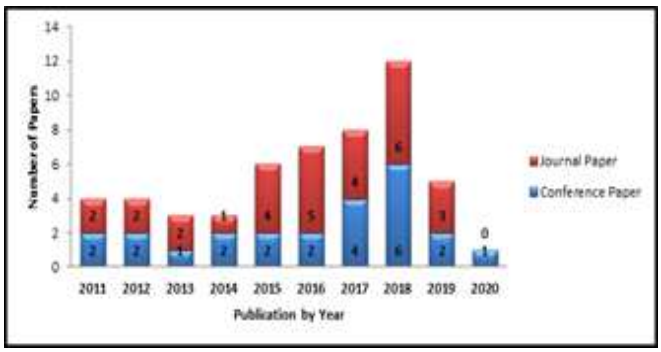

Fig. 4 Paper by year and document type

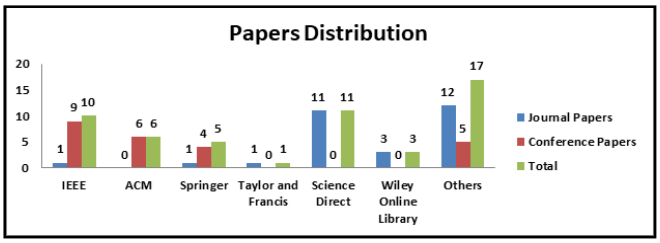

Fig. 5 Database wise distribution of research papers

The analyzed papers include 29 journal papers (55%) and 24 conference papers (45%). The list of selected papers is shown in Table V. This step is also documenting the particulars about the quantity of exclusion and inclusion of papers.

A. Research Question One (RQ1) Result

What are the factors that influence the TWP in ASD? We have determined several factors that may influence TWP in ASD. We observed that the factors reported in these studies were related to the teamwork characteristics and productivity in ASD [5]. These factors are classified according to Sudhakar *et al*. [20], Machuca-Villegas and Gasca-Hurtado [27], and Salas [49], as shown in Table VI. Table VI describes the reported factors based on 53 primary studies selected. It includes the main factor and their sub-factors with the related primary studies. The most reported factors include communication (20 times), cohesion (10 times), team leadership (10 times), and motivation (10 times) in the selected studies. These categories and sub-factors are identified based on these 53 selected studies, as shown in Table V.

The identified factors in the technical factors category include team size, programming language, and agile practices. The identified factors in the non-technical factors category include team characteristics, team member characteristics, and task characteristics. The identified factors in the organizational factors are culture, structure, and working environments. The identified factors in the environmental factors are industry characteristics, industry instability, social impact, and political impact. The identified factors in project management are schedule, cost, risk, scope, resources, and quality. The identified requirements level factors are user stories, requirements workshop, product owner, and external factors. Table V shows the final list of selected papers while the details of factors and sub-factors are identified after reviewing the papers selected, as shown in Table VI.

TABLE IV
EXISTING APPROACHS FOR TEAMWORK PRODUCTIVITY FACTORS

S.No	Paper Reference	Method	Description	Year	Type: Conference/Journal
1.	Factors Affecting Software Development Productivity: An empirical study	Empirical study	This empirical study led to the discovery of interesting factors that show how the different factors do (or do not) affect productivity in software development projects and in open source Projects.	2019	Conference
2.	An Instrument for Measuring Perception about Social and Human Factors that Influence Software Development Productivity	Survey-based study	This study developed and validated an instrument to measure the perception of software development team members about social and human factors (SHFs) that affects their productivity.	2021	Journal
3.	Productivity, Turnover, and Team Stability of Agile Teams in Open-Source Software Projects	The individual velocity of developers and focus factor of teams per iteration	This paper analyzed the productivity of open-source projects using measures that are popular in the context of agile software development.	2020	Conference

4.	Social and Human Factor Classification of influence in Productivity in Software Development Teams	Systematic literature review processes and evaluation processes with a psychology expert	This research has classified social and human factors associated with the productivity of software development teams.	2018	Chapter in Book: Trends and applications in Software Engineering
5.	Effective Social Productivity Measurements during Software Development: An Empirical Study	Quantitative measurement	This paper analyzed the impact of selected team-based variables over the latent constructs of productivity.	2016	Journal
6.	Using Qualitative System Dynamics in the Development of an Agile Teamwork Productivity Model	System dynamic model	This study developed a productivity model to analyze the interactions among the main factors of agile software development teamwork productivity.	2018	International Journal on Advances in Software
7.	Influence Factors in Software Productivity - A Tertiary Literature Review	Survey and overviews	This paper extracted and classified the influence factors into organizational factors (Organizational-dependent factors) and human factors (people-dependent factors).	2018	Journal
8.	What Predicts Software Developers' Productivity?	Survey-based approach	This paper talks about the factors and to correlate these factors with productivity	2019	Journal
9.	An Empirical Analysis of the Effect of Agile Teams on Software Productivity	Empirical Study	This article empirically distinguish the teamwork productivity factors and to specify how agile teams can have a productive impact on the software.	2019	Conference
10.	An Empirical Study on the Factors Affecting Software Development Productivity	Empirical study	This paper reports on an empirical study which was carried out to investigate whether and to what extent productivity is influenced by a number of factors.	2018	Journal

TABLE V
LIST OF SELECTED PAPER

S.No	Extracted Factors	Q.A	S
[S01]	Behavioral Factors (maturity, complexity, complex environment), Leadership, motivation, organizational culture, collaboration, communication, work environment,	0.5	[50]
[S02]	Team Leadership, Mutual Performance monitoring, backup behavior, adaptability, team orientation, shared mental models, mutual trust, communication	1.0	[2]
[S03]	Teamwork, communication, leadership, motivation, cohesion, flexibility	1.0	[51]
[S04]	Developers experience, lack of experience in manager, working environment, training, schedule Pressure	1.0	[52]
[S05]	Shared mental models, communication, trust	1.0	[53]
[S06]	Team member characteristics, nature of the task, organizational context, supervisory behavior, cohesion, communication, conflict management, coordination, sharing of expertise, and work procedure, agile practice	1.0	[30]
[S07]	Team inputs (task design, interdependence level, team composition), team processes (effectiveness, collective support, sharing tasks, communication), cohesion	1.0	[25]
[S08]	Transactional and transformational leadership, team politics, collectivism, cooperation, team (empowerment, performance, agility)	1.0	[54]
[S09]	Working environments (Social and Physical)	1.0	[55]
[S10]	Project management factors (schedule, cost, scope, risk, quality), and self-organization	1.0	[19]
[S11]	Communication, collaboration trends, clustering tendency, team awareness	0.5	[56]
[S12]	Team climate factors, organizational climate, group cohesion, collaboration, triggering factors, personality factors	1.0	[57]
[S13]	Personnel factors	0.5	[58]
[S14]	Organizational, people, process, technical project	1.0	[59]
[S15]	Team maturity, communication, feedback	1.0	[60]
[S16]	Communication, coordination, member contribution, mutual support, effort, cohesion	1.0	[61]
[S17]	Goals, roles, interdependence, leadership, communication, feedback, decision making, planning, implementation, conflict management, shared responsibility, organizational support	1.0	[62]
[S18]	Backup behavior, conflict management, effective communication, cohesiveness, mutual support, shared decision making, roles, goals	1.0	[63]

[S19]	Team (diversity, member competencies, characteristics, conflicts)	0.5	[60]
[S20]	Self –organization	0.5	[64]
[S21]	Agile practices and customer satisfaction	0.5	[65]
[S22]	Agile and hybrid development practices	0.5	[66]
[S23]	Organizational culture	0.5	[67]
[S24]	Knowledge of capability, competence, and team measurement	0.5	[68]
[S25]	Organizational support, environmental factors, communication, atmosphere	0.5	[69]
[S26]	Task completion time, artifacts, stakeholder's satisfaction, personal behavior	0.5	[70]
[S27]	Team (effectiveness, management, motivation), customer satisfaction	1.0	[71]
[S28]	Inter-team relations, team (speed, vision, member related factors, velocity, empowerment, leadership, lead roles)	1.0	[24]
[S29]	Coordination and leadership, SE tasks, communication, organizational context, knowledge management tasks, balance of workload, team composition, autonomy restrictions team cohesiveness, effort of team members, close collaboration, adaptability, external factors, mutual support, mutual trust	1.0	[3]
[S30]	Communication, team orientation, effort, back-up behavior, mutual support, motivation, trust, shared mental models	1.0	[37]
[S31]	Leadership	0.5	[72]
[S32]	Team diversity, commitment, motivation, reliable requirements, project constraints, experience, work environment, wage, workspace, development tool, project management (schedule, cost, risk, scope, quality)	1.0	[23]
[S33]	Coordination, leadership, communication, cohesion, collaboration, mutual support, mutual trust	1.0	[4]
[S34]	Communication, team orientation, effort, back-up behavior, mutual support, leadership, motivation, shared mental model, feedback	1.0	[73]
[S35]	Hybrid process, Rational unified process	0.5	[74]
[S36]	Team orientation, team leadership, coordination, skills, team effectiveness	1.0	[75]
[S37]	Technical and non-technical factors, project size, organizational and team culture, capabilities, experience, environmental and project factors (schedule, requirements stability factors, team size)	1.0	[22]
[S38]	motivation (external factors, customer satisfaction), team effectiveness (communication, coordination, mutual trust, leadership), team management (staffing, training, skills, team member turnover, staff turnover, goals, fair wage, team management, resource constraints, team size, collocation, diversity, Main staffs remained during the development, team design), programming language, agile practice, project complexity	1.0	[5]
[S39]	Team management, agile practices	1.0	[63]
[S40]	Technical factors, non-technical factors, organizational factors, environmental factors	1.0	[20]
[S41]	Communication, coordination of expertise, cohesion, trust, mutual support, value sharing, team performance	1.0	[76]
[S42]	Team (size, climate, cohesion), response time, task complexity	1.0	[21]
[S43]	Motivation	0.5	[77]
[S44]	Organizational culture, inter professional teamwork, job satisfaction, structure, leadership	1.0	[78]
[S45]	Communication, coordination, balance of member contribution, mutual support, effort, cohesion	1.0	[79]
[S46]	Working environment factors	1.0	[80]
[S47]	Communication and collaboration, team size, cohesion, project management factors	1.0	[17]
[S48]	Technical factors, non-technical factors, context factors, team member characteristics, task factor, project size	1.0	[26]
[S49]	Local system (job clarity, individual experience), global system (goal interdependence, user research), contextual system (management support, development time)	0.5	[81]
[S50]	Adaptability, backup behavior, communication, mutual performance monitoring, mutual trust, shared mental models, team leadership, team orientation	1.0	[82]
[S51]	Team effectiveness, team management, motivation, customer satisfaction	1.0	[6]
[S52]	Programming language, business area, architecture types and the usage of CASE tools	1.0	[83]
[S53]	Social factors (interpersonal, team culture, team characteristics), Human factors (people management, emotional motivational, cognitive, personality, capabilities, and experience)	1.0	[27]

TABLE VI
IDENTIFIED TEAMWORK PRODUCTIVITY FACTORS WITH THE PROPOSED CLASSIFICATION

Main Factor		Extracted Sub-Factors and Sources	Number of Factors
1) Technical factors		Project size [S37], [S48], project complexity [S1] [S38], software reuse (S38), tool (case) usage [S38], agile methodology and practices [S21], [S39], [S06], [S38], Programming language [S52], [S38]	**6**
2) Non-technical factors	**Team Characteristics**	mutual performance monitoring ([50],[S02], backup behavior [S02], [S18], shared mental model [S02], [S05], [S30], [S34], [S50], adaptability [S02],[S29], [S50], feedback [S15], [S29], [S34], mutual trust [S02], [S29], [S33], [S38], [S50], cohesion [S03], [S06], [S07], [S12] [S16], [S33], [S41], [S42], [S45], [S47], communication [S01], [S02], [S03], [S05], [S06], [S07], [S11], [S15], [S16], [S17], [S18], [S25], [S29], [S33], [S34], [S38], [S41], [S45], [S47], [S50], conflict management [S06], [S17], [S18], [S19], sharing of expertise (coordination) [S06], [S41], [S16], [S29], [S33], [S36], [S38], [S41], [S45], mutual support [S16], [S18], [S29], [S30], [S33], [S34], [S41], [S45], self-organization [S10], staffing [S38], adequate technical training [S04], [S38], team skills [S36], [S38], team member turnover [S38], key personnel throughout the project [S13], [S38], staff turnover [S38], goals [S17], [S18], [S38], intra group wage inequality (fair wage) [S32], [S38], team measurement [S24], self-management [S27], [S38], [S39], [S51], [S53], resource constraints [S32], [S38], team size [S37], [S38], [S42], [S47], team collocation [S38], team	**37**

		diversity [S19], [S32], [S38], team maturity [S01], [S15], team structure [S44], team velocity [S28], team effort [S16], [S29], [S34], [S45], team vision (progress) [S28], team climate [S12, S42], team autonomy [S29], team culture [S37], [S53], team empowerment [S08], [S28], team orientation [S02], [S30], [S34], [S36], [S50], team leadership [S28], [S29], [S31], [S33], [S34], [S36], [S38], [S44], [S45], [S50]	
	Characteristics of team member	knowledge [S29], skills [S36], [S38], motivation [S01], [S03], [S27], [S30], [S32], [S34], [S38], [S43], [S51], [S53], personality [S12], [S53], capabilities [S37], [S53]	**5**
	Task characteristics	Task variety and innovation [S06], [S07], [S26], [S29], [S42], [S48], task duration [S06], [S07], [S26], [S29], [S42], [S48], task cohesion [S06], [S07], [S26], [S29], [S42], [S48]	**3**
3) Organizational factors		Culture [S01], [S23], [S37], [S44], Climate [S12], Diversity [S40], Structure [S40], [S44], Values [S29], [S40], Mission [S14], [S40], Maturity level [S17], [S40], Services [S06], [S40], Rewards [S25], [S38], [S40], Training [S25], [S40], Resources [S25], [S40], Working environment [S04], [S09], [S40], [S46]	**12**
4) Environmental Factors		Industry characteristics [S25], [S37], [S40], industry instability [S25], [S37], [S40], social impact [S25], [S37], [S40], political impact [S25], [S37], [S40]	**4**
5) Project Management Factors		Project Schedule [S10], [S04], [S32], [S37], [S06], [S38], [S47], Project Scope [S10], [S32], [S06], [S38], Project Cost [S10], [S32], [S06], [S38], [S47], Project Risk [S10], [S32], [S06], [S38], Project Resources [S10], [S32], [S06], [S38], Project Quality [S10], [S32], [S06], [S38]	**6**
6) Requirements Level Factors		User stories [S06], [S28], Requirement's workshop [S28], [S32], [S37], product owner [S06], [S28], external project factors [S06], [S28], [S38]	**4**
		Total Factors	**77**

The "S" shows the study in Table V. Maximum numbers of the stated factors are associated with ASD teams as shown in Table V. Fig. 6 shows that 58% of total recognized factors depend on non-technical factors, and only 42% of them depend on the technical, organizational, environmental, project management, and requirements level factors of the teamwork. It shows that non-technical factors are more dominant as compared to other identified factors.

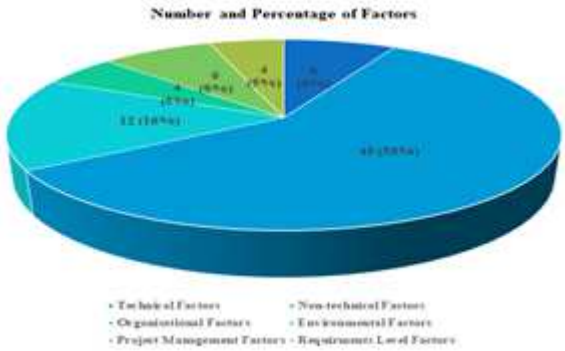

Fig. 6 Factors affecting teamwork productivity by responsible

B. Research Question Two (RQ2) Result

Which factors may be classified as TWP factors in ASD? To achieve this and address the proposed classification, we used practices like grouping by synonyms [22] or semantic similarity [84]. Furthermore, the outcomes from the studies [26], [27] were used as an idea to refer to the groups and classification of some factors developed for this study (Table VI). A classification organization was distinct to assist the complete factor groups and classifying process. To achieve the required classification distributions of the factors into the proposed categories, we have implemented the technical, non-technical, and human approach categorization of factors [18], [20], [22], [26], [27], [84]–[86]. Thus, it became very important to consider other categories to be added to those factors which did not fit into the existing one. The additional identified categories were included (organizational factors, environmental factors, project management factors, and requirements level factors) were classified, as per the objectives hereof.

Table VI defines the categories used to classify the described factors. The technical factors included six sub-factors, while the non-technical factors are further divided into three sub-categories (37 team characteristics, five team member characteristics, 3 task characteristics). Similarly, organizational factors included twelve sub-factors, environmental factors included four sub-factors, project management factors included six sub-factors, and requirements level factors are having four sub-factors. Table VI presents 77 factors, which were classified as a part of this process. Each classification category shows the number of main influential and the predominant factors in Table VI as well. In the circumstances, only an associated factor was considered when that factor associates with a specific category of factors owing to their resemblance. Several factors counted in the non-technical category compared to the technical factors group, which exhibit fewer factors (Table VI).

Furthermore, during the classification process, the identified factors were assessed which were matched with more than one factor. Based on the analysis, the most prominent reported factors are included, shared mental model, mutual trust, cohesion, communication, conflict management, sharing of expertise (coordination), mutual support, team leadership, and motivation, which were evaluated under the similar name in the primary studies reviewed. In this study, 77 influential factors were identified in the context of TWP based on 53 primary studies on the relevant subjects in the current years. These factors probably characterize the utmost substantial to be considered by software organizations. There was no common classification in the literature that we could find. Nevertheless, the study showed a number of resemblances among the different categories. Based on these similarities, we created different classifications adopted for this work: technical, non-technical, organizational, environmental, project management, and requirements level factors.

The significance of the list of TWP factors was reinforced by Wagner and Ruhe [22] to support software organizations, in which we agree. It is very helpful for software organizations by having a list of factors as shown in Table VI. The list can guide these organizations to understand where they need to start and how to control and analyze these factors in their specific environment. The software organizations can easily determine these factors' significance and impact on their software projects by working on these steps. Furthermore, they can decide what they need to consider and what not. These identified factors and categories will help software teams, readers and organizations to consider these factors accordingly in terms of these identified factors. Specifically, these factors and categories will be beneficial for the software professionals working in software organizations to improve teamwork productivity and develop successful software projects in ASD. In another study, Trendowicz and Münch [85] established that their prevalent outcome is to perceive that the software project's success mostly depends on the people working with the teams.

The researchers and developers have mostly focused on the skills of members involved in teams, and also, the consistent requirements are the most essential factors which are considered by them [86]. It was also perceived by Dutra *et al.* [84] that communication between the team members and individual motivation are the most important factors which are considered by the ASD teams. In another study led by Sudhakar *et al.* [20] identified several factors in the context of the software team, which influence the productivity of ASD teams. Moreover, the author suggested a classification that categorizes these factors into four main factors: technical, non-technical, organizational, and environmental factors. Furthermore, the author proposed team related factors including climate, diversity, innovation, member characteristics, leader behavior, and uppermost management support that can affect the TWP. The significance of TWP factors in ASD is vibrant from the conclusions on the basis of primary studies. There is always a debate on the need to measure productivity as there are diverse observations existed regarding the definition of productivity in ASD, however, the productivity is a measurable concept [20].

Productivity in ASD is related to timeliness, quality, quantity, team satisfaction, and customer satisfaction, and such concepts should be measured when research on productivity is performed [9]. Furthermore, different authors [5], [30] studied product quality, customer satisfaction, work produced, and efficiency. These studies further suggested that these concepts need to be measured whenever research is carried in terms of productivity in ASD. It is suggested that these identified factors were mostly related to the TWP in ASD. It is also recommended that the agile teams control these influential factors to be more productive for successful software development. It is further suggested that all factors related to teamwork defined in Israt and Kazi [5], Iqbal *et al.* [24], Melo *et al.* [30] were stated as factors affecting agile TWP. These factors include communication, sharing of expertise, mutual support, effort, the balance of member contributions, shared mental model, feedback, mutual trust, and cohesion.

The factors identified in this study are mostly related to TWP, which also pertained to agile principles (individual support and their interrelationship). These outcomes also recommend an association between agility and team maturity [60], [87]. In total, according to the classification, we identified 77 factors that influence the teamwork productivity of ASD: technical, non-technical, organizational, environmental, project management, and requirements level factors. Additionally, the SLR allowed us to find the most influential teamwork factors: communication, cohesion, motivation, and team leadership. Table VI shows the identified factors with its main classification.

C. Plan for Validation

For securing an ultimate TWP factors classification, the identified groups of factors must be validated. For this purpose, an empirical approach using the survey technique will be used to get feedback from the professionals. It will be including software engineers, developers, project managers, business experts, and academicians in different software organizations in Pakistan. Since the last decade, Pakistani software organizations are very rapidly adopting agile methodologies for software development. Therefore, the survey will be conducted in the software organizations of Pakistan. Five major cities were the feedback target as most software organizations located where extensive development and research is conducted on agile methodologies. The major companies are located in these five cities of Pakistan, including Islamabad, Karachi, Rawalpindi, Lahore, and Peshawar. The survey will be sent out to 1157 software organizations in these five major cities, while the total numbers of software organizations are 4464 throughout Pakistan.

An online questionnaire was designed to collect the responses from the respondents. The questionnaire that will be designed for the proposed study is organized mainly in four sections. The first section will contain the demographic data, while the second section will be based on the perception of project failure or success as well as measuring productivity criteria. The third section is mainly concerned with six productivity influence factors, including 1) technical factors, 2) non-technical factors, 3) Organizational factors, 4) Environmental factors, 5) Project management factors, 6) Requirement's level factors. These six factors will contain a total number of 77 sub-factors. The last section is concerned about the overall project success and for the respondent feedback to express their additional views generously in the context of TWP factors for ASD.

For the proposed study, the research instrument is the main step to follow, which needed to be reviewed by the relevant experts. According to the literature, the researcher mostly used 4 -7 experts in their researches, while this number could be beyond 20 experts. However, there is no such problem if this number exceeds twenty validates, but usually, minimum numbers are preferred. In another study conducted by Oslon [88], usually, the instrument reviewed by six experts is preferred [89], [90]. All the expert reviewers have experienced, and specialist cut across software engineering, ASD, and questionnaire assessment. The quantitative data analysis will be done using Statistical Package STATA and Analysis of Moment Structures (AMOS) to analyze the data collected through questionnaires. The proposed study will use Structural Equation Model (SEM) using the AMOS

program to assess the proposed relationship amongst the factors under consideration. According to Anderson and Gerbing [91], construct validity will be evaluated by running a confirmatory factor analysis (CFA) before testing the hypothesized paths using the SEM. SEM delivers a utilization to take the model's measurement error in the observed variable (both independent and dependent). The T-test and F-test will also be used for statistical hypothesis testing. Since the proposed research uses an exploratory approach to find out which teamwork factors can impact (positively or negatively) the productivity of ASD. It is appropriate for a SEM model, where the association between multiple Independent Variables and the Dependent Variables is determined, and where the comparative prognostic significance of the independent variables is established [9].

D. Threats to Validity

In this study, we have identified TWP factors on the basis of an extensive literature review, which leads to a few threats to the firmness of the outcomes of this study. These are the biasness of researcher, field selection, problems in operations, extraction of data inaccurately, and problems in factors classification. To avoid the biases during the literature review process, the process was thoroughly managed and reviewed by other researchers. The researcher was selected based on experience in the field of software engineering and specifically in ASD. A comprehensive literature review was conducted to identify the TWP factors, which followed the whole SLR protocol. However, this study was based on other studies [26], [27], which completely systematically followed the SLR process. Although this review is comprised of an SLR, the proposed study maintained the full implementation of this work. This study is adopted the recently conducted studies while the studies which are outdated contains the relevant information, therefore it was considered.

In our SLR protocol, an inclusion and exclusion criteria [43], was used to control the inaccuracies in data extraction. This criterion also emphasizes to minimize the discrepancies during the process of extracting data. However, there is some biasness may occur in the classification process of TWP factors due to lacking details in the explanation of factors. To prevent this threat, another researcher was involved in validating it and reviewed the amalgamation approaches used by other authors, such as factors unification by name, semantics, or depiction. Furthermore, in summation, we will validate these factors and their classification by software engineers, developers, project managers, business experts, and academicians through a survey-based approach.

IV. Conclusion

In this study, we have identified the reported factors and proposed a classification of the teamwork factors that may influence the productivity in ASD. The factors identified in the study mostly depend on agile teamwork and affect productivity positively, and mostly the productivity level of these studies was related to team level in ASD. We have identified 77 factors from a sample of 53 primary studies evaluated through SLR established for the purpose of this study. Furthermore, these 77 factors were classified into six main categories: technical, non-technical, organizational, environmental, project management, and requirements level factors. For each category, a set of factors is defined to group them by semantics and function to enable their dealing for future use. On the basis of these influential factors of TWP presented in this study, may be used as the base factors for the purpose of initiatives to increase the ASD productivity. The results of this research will be used to propose strategies for ASD teams to solve problems by using or applying these characteristics of teamwork to influence productivity. The identified categories will help researchers to provide better solution in the development of software and will ultimately the researchers will provide new solutions for their specific software development.

Based on the proposed study, the researchers will provide new solutions as the proposed study presents the analysis of the existing literature from different perspectives. The researchers can take help from the current study as evidence to the existing literature. The data will come the questionnaire and then will be analyzed to extract meaningful information for the software organizations. The proposed study will be used as evidence in the software organizations. We identified the reported factors that affect teamwork productivity in ASD; most of them were related to non-technical factors, and are related to communication, coordination, cohesion, motivation, shared mental models, and sharing of expertise (coordination). Most of the identified factors depend on agile teams and positively affect productivity, and the most studied productivity level in ASD was teamwork. By implementing these factors may have a positive impact on the software development team. Therefore, the software organizations need to work out with these factors by practicing these factors by their professionals to determine its impact on the teamwork productivity and can make improvements in their processes. However, it is significant for software organizations to balance their productivity improvement actions by considering a combination of these identified factors well suited to their organizational context. In the future, we are formalizing the validation plan to empirically analyze these identified TWP factors and their classification in ASD by conducting a widespread survey using questionnaire in the well-known software organizations in Pakistan. Furthermore, a TWP model will be proposed to validate it using structure equation modeling, which will support software organizations to improve their productivity using ASD.

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