Work Engagement in Agile Teams: The Missing Link Between Team Autonomy, Trust, and Performance?

Marte Pettersen Buvik[(✉)] and Anastasiia Tkalich

SINTEF Digital, Trondheim, Norway
{marte.p.buvik,anastasiia.tkalich}@sintef.no

Abstract. To have engaged and high-performing agile teams are what most organizations strive for. At the same time, there is little research on the drivers of team work engagement in the software context. Team autonomy and trust are crucial for agile teams and are suggested as potential boosters of team work engagement and performance. In this study, we apply the Job Demands-Resources model to examine the role of autonomy and trust and their impact on work engagement and team performance in agile teams. We analyze quantitative survey data from 236 team members in 43 agile teams to examine how team autonomy and trust relate to team work engagement and how engagement mediates the relationship between these factors and performance. Our results show that while both autonomy and trust are positively related to team work engagement, team trust plays a more critical role than team autonomy. Teams with high team trust showed higher engagement, which enhanced team performance. Our results highlight the importance of social factors such as trust in creating conditions for high performance in agile teams through its effect on team work engagement.

Keywords: Agile teams · Team performance · Trust · Team autonomy · Work engagement · Job demands-resource model

1 Introduction

Having high-performing agile software development teams is what most organizations operating in the field strive for. Among the numerous determinants of team performance, *autonomy* and *trust* deserve special attention when it comes to agile teams. Team autonomy is considered crucial for team performance because it allows teams to self-organize and make better decisions without needing to wait for approval [1, 2]. When it comes to team trust, it has been found to be one of the fundamentals of agile teams [3] as it creates favorable conditions for cooperation by strengthening the interactions between team members and improves problem-solving and overall software quality because team members that trust each other are more likely to share knowledge and report problems.

Although both team autonomy and trust are acknowledged as crucial for agile teams, there is a lack of theoretical explanation for how these factors impact performance. One possible explanation may be found in the Job Demands-resource model (JD-R), which

depicts *work engagement* as a mediator of the relationships between job resources (e.g., team autonomy and trust) and performance [4]. In other words, factors such as team autonomy and trust may relate to work engagement, while work engagement, in its turn, relates to team performance.

Work engagement is in itself important for agile teams because it is closely related to the concept of motivation. According to the 5th principle in the agile manifesto, agile projects should be built around motivated individuals that have support and trust to get the job done. Motivation has been described as an important issue in software engineering [5], and job enthusiasm has been highlighted as the strongest predictor of developers' productivity [6]. Motivated teams are also highly engaged, which means they are full of energy, enthusiastic about their work, and persist when facing drawbacks. Research shows that engaged teams outperform teams with low levels of engagement [7].

Recently the interest in work engagement is starting to emerge in the field of agile. For example, Huck-Fries et al. [8] demonstrate that work engagement in agile teams is indeed influenced by job resources and that agile practices are positively related to these resources. However, there is still insufficient insight into the effects of job resources and work engagement on the performance of agile software development teams. Against this background, we are suggesting the following research question: *What are the effects of team autonomy and team trust on team work engagement and team performance in agile software development teams?*

To answer this question, we develop and test a statistical research model that investigates how team autonomy and trust relate to team work engagement and how team work engagement mediates the relationship between these resources and team performance. We use survey data from 236 team members in 43 software development teams in Norway. Our results have important theoretical and practical implications for the field of agile development and contribute to the existing literature in several ways. First, we show how a well-established psychological theory (JD-R) can be successfully applied to examine agile teams. Second, we expand the research on JD-R theory by including the team level of analysis. And third, we provide valuable theoretical as well as practical insights by showing how team autonomy and trust relate to work engagement and performance of agile teams.

2   Related Work and Hypothesis Development

2.1   Team Work Engagement in Agile Software Development Teams

Software development teams now commonly adopt agile methods, which emphasize the importance of a collaborative, people-oriented approach with the use of self-organizing teams with high levels of autonomy [1, 9]. With the increased use of teams in software development, there is a growing recognition of factors that influence the performance of teams in this context. While the Agile Manifesto is based on the idea of highly motivated team members [10], empirical research on work engagement in the agile development literature is still limited.

Work engagement can be defined as a positive, fulfilling, work-related state of mind characterized by vigor, dedication, and absorption [11]. Vigor is described by high levels of energy while working and persistence in the face of difficulties. Dedication refers to being strongly involved in one's work and experiencing a sense of significance, enthusiasm, and strong identification with the work. Absorption means being fully concentrated and immersed in one's work and difficulties with detaching oneself from work. In sum, engaged employees feel full of energy, are enthusiastic about their work, and often lose track of time when working. Based on an abundant amount of research, work engagement has been found to have numerous benefits, such as organizational commitment, job satisfaction, extra-role behavior, and superior work performance, as well as increased well-being and general health [12]. Although most studies on work engagement focus on the individual level of measurement, the concept also exists at a team level [7, 13]. *Team work engagement* (TWE) describes a shared perception of work engagement of the team as a whole and can be defined as "a positive, fulfilling, and shared emergent motivational state that is characterized by team vigor, team dedication, and team absorption, which emerges from the interactions and shared experiences of members of a team" [13].

2.2 Work Engagement and the Job Demands-Resource Model

The JD-R model has frequently been used as a framework to explain the antecedents and consequences of work engagement [14]. According to the JD-R model, working conditions can be broadly classified into two categories; job demands and job resources. Job demands are the aspects of the job that require sustained physical and/or psychological effort and are therefore associated with certain costs. Examples are high work pressure, role conflict, and emotionally demanding interactions. Job resources refer to the job-related aspects that are functional in achieving work goals that allow employees to cope with the demanding aspects of their job and stimulate their learning and development [14]. Job resources may exist at different levels: the task level (e.g., job autonomy), the social level (e.g., team climate), and the larger organizational level (e.g., organizational justice). The JD-R model further suggests that job demands and job resources trigger two distinct psychological processes: health impairment and the motivational process. The health-impairment process posits that poorly designed jobs or constant job demands exhaust employees' resources resulting in stress and health problems [15]. The motivational process, on the other hand, proposes that job resources both have intrinsic and extrinsic motivational potential and lead to high work engagement. Resources are intrinsically motivating because of their capacity to fulfill basic human needs such as autonomy, belongingness, and competence [16], and may also be extrinsically motivating because they translate into instrumental help that allows employees to successfully achieve work goals [14]. Research has consistently shown that job resources are the strongest predictors of work engagement due to their potential to enable employees to cope with demanding aspects of their job and, at the same time, stimulate personal growth, learning, and development [12, 17].

Some recent research indicates that agile work practices have a positive effect on work engagement through job resources [8, 18, 19]. Huck-Fries et al. [8] found, for instance, that agile practices significantly influenced the job resources of job autonomy and perceived meaningfulness, which again positively predicted team members' work engagement. Similarly, Rietze and Zacher [19] demonstrated that agile work practices were positively related to job resources such as autonomy, peer support, and feedback and indirectly influenced work engagement via these job resources. Neither of these studies, however, studied job resources and work engagement at the team level. Further, the mediating effect of work engagement on the relationship between job resources and team performance is lacking in the previous studies on work engagement in agile software development teams. In the software engineering literature, team autonomy and team trust have continuously been identified as central to the effectiveness of agile software teams [3] and have also been recognized as important resources in the work engagement literature [20].

2.3   Team Work Engagement, Team Autonomy, and Trust

While many types of job resources may boost work engagement [14], previous meta-analyses and reviews suggest that resources at the task level, such as autonomy, are strong drivers for work engagement [17, 21]. Indeed, recent findings indicate that team autonomy is positively related to work engagement, suggesting that team members with a voice in allocating tasks, managing time, and defining leadership roles express greater vigor, dedication, and absorption at work [22]. Team autonomy is a key principle of agile practices and is recognized as an important condition for the responsiveness and effectiveness of agile software development teams [1]. Team autonomy can be defined as the extent to which the team has considerable discretion and freedom in deciding how to carry out tasks [23]. The increased levels of autonomy in the team bring decision-making authority directly to the operational level resulting in increased speed and accuracy of problem-solving [1]. The self-determination theory (SDT) also suggests that autonomy triggers the motivation of team members and may thus increase the level of engagement. Muecke and Greenwald [24] suggest that autonomy influences work engagement through both motivational and cognitive mechanisms, leading to job enrichment. The motivational perspective suggests that autonomy affects work engagement by influencing employees' feelings of personal responsibility for work outcomes, feelings of mastery, and increased chances for learning and growth, all leading to higher motivation [25, 26]. The cognitive perspective focuses on the cognitive demands caused by job autonomy, such as increased problem-solving and information processing. As autonomy increases, employees are allowed to choose suitable strategies to deal with situations, resulting in more cognitive activities and higher cognitive demands that promote work engagement. Based on this review, we, therefore, hypothesize that: *H1: Team autonomy is positively related to team work engagement.*

Trust in the team represents a potentially vital job resource for agile teams because trust constitutes a central determinant of effective teamwork [27, 28] and has been found to play a crucial role in the functioning of teams in this context [3]. Trusting one's teammates implies positive expectations about their actions and motivation grounded in the belief of their competence, integrity, and benevolence [29]. It is proposed that a high level of trust within the team can positively boost the team's work engagement in several ways. For example, if team members trust their fellow teammates, they are confident that they have the competence to do their job and would not intentionally do anything to compromise them or the team. This could influence the motivation of team members and the collective engagement in the team. The confidence in their fellow team members may also increase their willingness to commit themselves to the goals [27] and increase their level of work engagement. By contrast, if team members lack confidence in their fellow team members and feel that they are not competent to do their tasks, they may not exert the effort and energy necessary for the team to succeed. In addition, if team members believe that their co-workers are consistent and would do what they say they will do, this could contribute to higher work engagement because they would be able to focus on achieving their tasks and goals as opposed to expending their energy and focus on monitoring and controlling actions of their fellow team members. Also, the support, mutual respect, and encouragement of fellow teammates provide team members with feelings of being accepted and cared for, satisfying their need for belonging and relatedness [16], thus increasing their work engagement. In addition, trust within the team has been found to facilitate the open sharing of knowledge and ideas in teams [28]. The increased sharing of knowledge and the presence of shared information may boost the team's engagement [30]. Trust as a resource at the team level has not been extensively studied in the work engagement literature. However, related factors such as social support have frequently been included in the work engagement and JD-R studies. At the team level, Torrente et al. [7] found that social resources such as supportive team climate, collaboration, and teamwork were positively related to team work engagement. Based on this review, we hypothesize that: *H2: Team trust is positively related to team work engagement.*

2.4 Team Work Engagement as a Mediator Between Job Resources and Team Performance?

Both the JD-R model and the SDT propose that engagement leads to a higher level of performance because of the fulfillment of psychological needs, which enhances intrinsic motivation. Indeed, work engagement at the individual level has been found to predict task performance and extra-role performance [17]. Christian et al. [17] suggest that engaged employees are more persistent and pursue their tasks with more intensity, making them more focused on their work tasks and thus promoting higher task performance. While the empirical studies on team work engagement so far are relatively limited, some findings show a positive relationship between team work engagement team performance, with engaged teams outperforming teams with lower levels of engagement [7]. Explanations for this might be that engaged teams are able to maintain high motivational levels, resulting in greater commitment to collective goals and focused action on goal achievement [31]. Furthermore, engaged team members consider their work meaningful and

relevant [32]. Also, engaged teams create a positive and activated affective climate that is characterized by high levels of energy and feelings of pleasure while working. This positive affective climate is beneficial for the performance of teams. Based on this, we hypothesize that: *H3: Team work engagement is positively related to team performance.*

The JD-R model proposes that work engagement mediates the impact of job resources on organizational outcomes [33]. Previous research has lent support for the mediating role of engagement, indicating that resources at the team level will have an indirect effect on team performance. Indeed, Torrente et al. [7] reported evidence for at mediation role of team work engagement between social resources and team performance in their sample of 63 teams. And Costa et al. [32] also showed that team members job resources positively affected work engagement and, consequently, team performance. In line with this, we propose H4*: Team work engagement mediates the relationships between team autonomy and team performance. H5: Team work engagement mediates the relationships between team trust and team performance.*

Taken together, we hypothesize that the job resources, team autonomy, and team trust will both be positively related to team work engagement (H1 and H2). Team work engagement again will positively influence team performance (H3) and will mediate the relationship between team autonomy and team performance (H4) and team trust and team performance (H5). Figure 1 illustrates our research model and hypotheses.
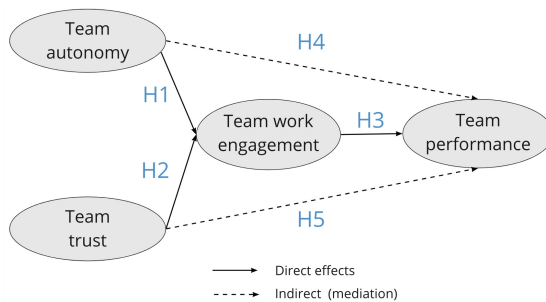
Fig. 1. The research model and the hypothesis

3   Method

In this section, we outline the sample and its context, the data collection process, the measures employed, and the statistical procedures used.

To test the proposed hypotheses, we conducted a quantitative study with survey data from software development teams in four companies in Norway, representing IT consultancy within software development and fintech. The teams included in the survey employ various agile practices, which are summarized in Table 1, along with information about the industry, number of employees, and number of teams included in the study.

Table 1. Description of the sample and its context

Company	A	B	C	D
Industry	IT consultancy	IT consultancy	FinTech	FinTech
No. of employees	150	750	2000	300
No. teams	7	12	14	10
Agile practices	Customer-centered teams with high autonomy using agile practices influenced by both Scrum and Kanban, including daily standups, backlog grooming and iterative planning	Self-organizing teams with common practices from Scrum and Kanban, such as standups, retrospectives, sprints, product backlogs, and visual task boards	Cross-functional teams with a combination of Scrum and Kanban with daily standups, sprint planning, backlog grooming, retrospectives, and lean startup principles	Cross-functional teams with Kanban-inspired ways of working, including daily standup, retrospective, and iterative planning

Email addresses from team members working in software teams were provided to the researchers, and the questionnaire was distributed and collected electronically via an online survey platform. All participants were given information about the purpose, data protection, and confidentiality before accepting the invitation to participate. In total, 239 team members from 45 teams responded. Two teams were excluded from the sample because they had fewer than three participants, leaving us with a final sample consisting of 236 team members from 43 teams, providing an overall response rate of 78 percent. The distribution of teams across the four organizations was 14, 10, 7, and 12. The team size ranged from 3 to 10 members, with an average of 5.5 members per team. A total of 72.7% of the participants were male, and the age distribution was as follows: 2.8% aged 18–24, 38.9% were 25–34, 34.1% were 35–44, 19% were 45–54, and 5.2% were 55 or older. All variables were measured with pre-existing validated measures. They were assessed on a Likert scale, ranging from 1 to 5 or 1 to 7.

Team autonomy was measured with six out of the eight original items from Langfred's [23] team autonomy scale. This is a modified version of a well-validated scale for individual job autonomy, adapted to the team level. An example of an item from the scale is *"The team is free to decide how to go about getting work done."* Team members were asked to assess how much they agreed with the statements concerning the team on a scale ranging from 1 ("completely disagree") to 5 ("completely agree").

Team trust was measured using a shortened version of the perceived trustworthiness in teams scale developed by Costa and Anderson [34]. An example item is: *"In this team, people can rely on one another."* Responses ranged from 1 (completely disagree) to 5 (completely agree).

Team work engagement was measured using the 3-item scale from the ultra-short version of the Utrecht work engagement scale [35], adapted to the team level by following

Costa et al. [13] using a reference shift from "I/me" to "we/our" to achieve the team focus. The items are: "*In our team, we feel bursting with energy at our work*," "*In our team, we are enthusiastic about our job,*" and "*In our team, we are immersed in our work*." The response alternatives ranged from 1 ("never the last year") to 7 ("every day").

Team performance was measured by three items based on scales developed by Jehn, Northcraft, and Neale [36]. Team members were asked to rate their team performance in terms of efficiency, quality, and overall performance. A sample item is: *"How would you assess your team performance in terms of efficiency?"* where the responses ranged from 1 ("very poor") to 5 ("very good").

Control variables included in the analysis were *team size* and *time spent in the team*, as these variables could potentially account for variance in the output variables. *Team size* was calculated based on how many team members from the team participated in the survey. We chose to proceed in this way because the average response rate per team was quite high (78%). The item for *time spent in the team* was *"How much of your time do you work on this team?"* (1 = less than 25%; 5 = around 90% or full-time). This measure was aggregated based on the scores provided by individual team members so that the scores represented the average for each team.

Data Aggregation. As all hypotheses in the present study refer to the team level of analysis, we aggregated the initially individual-level data to the team level. All the variables, except team performance, assumed a referent-shift consensus model [37]. In a referent-shift model, the referent is directed towards the team because these constructs are collective in nature. Rather than asking team members about their own individual perceptions, referent shift incorporates the team as a whole. In contrast, role clarity and team performance assumed a consensus model [37] with the referent items directed at the individual team members because the construct resides in the individual's own perception of how well the team performed. Both forms of models assume that team members share a common perception, and therefore, the interrater agreement is necessary to justify aggregation. To do this, we assessed the within-group agreement index $r_{wg(j)}$ [38] for all measures.

Data Analyses. Data analyses were performed using Stata/MP version 16.1, which is a commonly applied software tool for statistical analyses. To test the hypothesis in the research model, we used partial least squares structural equation modeling (PLS-SEM) as the data analysis procedure. This procedure is recommended for data with relatively small sample sizes, and it allows for avoiding issues with non-normally distributed data [39]. The reliability and validity of the model were assessed by evaluating the measurement model (how well the latent variables reflect the variance in the measured items) [39]. This was done based on indicator reliability (item loadings' size), composite reliability, convergent validity (average variance extracted (AVE)), and discriminant validity [39]. Composite reliability was examined by evaluating Dillon-Goldstein's rho (DG rho), which is an alternative to Cronbach's alpha, in which the recommended level should be above 0.7. Discriminant validity (whether latent variables are sufficiently independent of each other) was assessed by comparing AVE values to the squared correlations among the latent variables in the model.

We tested the hypothesis by assessing the structural part of the model. To evaluate mediating relationships, one must compare the indirect paths suggested by the mediators to the direct paths [40]. Variables may have no mediating effect (the indirect effect is insignificant), a partial mediating effect (if the direct effect is significant), or a full mediating effect (if the direct effect is insignificant) [39]. The significance of the indirect effects was assessed based on bootstrap tests with 10 000 repetitions which is the procedure recommended by Hair et al. [39]. Finally, we tested potential common method bias (CMB) in the model through variance inflation factor (VIF), which is argued to be a reliable indicator of CMB in PLS-SEM [41]. Researchers argue that CMB can lead to results that are not due to the constructs of interest but rather to the measurement method, especially when it comes to behavioral research [42]. As a remedy, the assessment of VIF allows for uncovering possible multicollinearity in a PLS-SEM model [41].

4   Results

Since our study focuses on the team level, we first report the results of the within-group interrater agreement test that is recommended to justify the aggregation. As shown in Table 2, all average $r_{wg(j)}$ values are at about the threshold of 0.7, which, according to Le Breton and Senter [38], indicates acceptable interrater agreement within teams. This justifies us in aggregating the data collected at an individual level to a team level. Table 2 also shows average values and standard deviations of the aggregated variables.

Table 2. Summary of the aggregated variables for all teams

Aggregated variable	M	SD	$r_{wg(j)}$	
			M	SD
Team autonomy	3.93	0.45	0.87	0.16
Team trust	4.54	0.29	0.88	0.16
Team work engagement (TWE)	5.61	0.54	0.78	0.24
Team performance	4.10	0.31	0.90	0.06
Control var: Time in teamteam	3.64	0.34		
Control var: Team size	5.49	1.54		

As shown in Table 3, all the standardized loadings are close to or above the recommended threshold of 0.7, AVE exceeds the recommended level of 0.5, and all D.G. Rho values are above the level of 0.7. These findings indicate acceptable indicator reliability, composite reliability, and convergent validity.

Table 3. The measurement model (step 3)

Latent variable	Items	Loadings	D.G. Rho	AVE
Team autonomy	6	0.730–0.927	0.937	0.710
Team trust	4	0.835–0.933	0.931	0.773
Team work engagement (TWE)	3	0.884–0.967	0.909	0.863
Team performance	3	0.794–0.954	0.909	0.770

All AVE values (Table 3) are larger than the squared correlations among the latent variables in the model, which suggests acceptable discriminant validity of the measurement model.

Table 4. Discriminant validity (Squared correlations < AVE)

	Trust	TWE	Performance	Autonomy	Team size	Time in the team
Trust	1.000	0.348	0.249	0.162	0.005	0.011
TWE	0.348	1.000	0.367	0.205	0.017	0.002
Performance	0.249	0.367	1.000	0.069	0.041	0.021
Autonomy	0.162	0.205	0.069	1.000	0.001	0.025
Team size	0.005	0.017	0.041	0.001	1.000	0.008
Time in the team	0.011	0.002	0.021	0.025	0.008	1.000
AVE	0.773	0.863	0.770	0.710	1.000	1.000

Table 4 summarizes both direct and indirect effects in the model with "team work engagement" (TWE) and "team performance" as outcomes. Taking into account the potential relationship between "team autonomy" and "team trust" as job resources, we present the coefficients in a stepwise fashion. In Step 1, we entered "team autonomy" as a predictor, whereas "team trust" was entered in Step 2 and the control variables in Step 3. All the significant effects are highlighted in bold (Table 4).

In Step 1 we see that "team autonomy" has a positive direct effect on "team work engagement" ($\beta = .453$, $p < .01$), whereas "TWE" in turn has a positive effect on "team performance" ($\beta = .613$, $p < .001$). This means that teams with higher autonomy could be expected to also have a higher level of work engagement; and that the teams where the members were highly engaged also showed increased performance. There was no significant direct effect of "team autonomy on "team performance", whereas the indirect effect was significant ($\beta = .277$, $p < .05$). The combined findings at this step show an *indirect-only mediation* (according to Zhao et al. [40]) between "team autonomy" and "team performance" ($\beta = .277$, $p < .05$), meaning that "TWE" fully mediated the relationship between the two variables. For this step, we could conclude that "team autonomy" functions as a job resource, thus strengthening teams' engagement which then leads to subsequent increased performance.

Table 5. Summary (stepwise) of the effects with standardized path coefficients

	Step 1		Step 2		Step 3	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Autonomy → TWE	**0.453****		0.257		0.251	
TWE → Performance	**0.613*****		**0.494****		**0.443****	
Autonomy → Performance	−0.014	**0.277[1]***	−0.056	0.127[2]	−0.024	0.111[4]
Trust → TWE			**0.487****		**0.503****	
Trust → Performance			0.232	**0.241[3]****	0.276	**0.223[5]***
Time in the team – TWE					−0.037	
Team size → TWE					0.159	
Time in the team → Performance					−0.179	-0.012
Team size → Performance					0.148	0.070

Note. For the indirect effects the p-value is linked to the bootstrap test (10000 repetitions). 95% CI [1](0.112, 0.571); [2](−0.017, 0.256); [3](0.085, 0.454); [4](−0.024, 0.375); [5](0.036, 0.467). *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

In Step 2, we entered "team trust" as the second independent variable in the model. As shown in Table 5, "team autonomy" had neither direct nor indirect effect on "team performance" when controlled for "team trust". At the same time, "team trust" showed a strong direct effect on "team work engagement" ($\beta = .487, p < .01$), which indicates that teams with a high level of trust were often highly engaged in their work. We also observed a significant indirect effect of "team trust" on "team performance" mediated by "TWE" ($\beta = .241, p < .01$). Since "team trust" did not have any direct effect on "team performance", we concluded an *indirect-only mediation* (full mediation) between these two variables. We concluded that in Step 2 "TWE" fully mediated the relationship between "team trust" and "team performance" when controlled for "team autonomy". In other words, "TWE" functioned as a mediator between "team trust" and "team performance", but not between "team autonomy" and "team performance", as it was in Step 1 when we did not control for "team trust". In Step 3, the same results were validated by entering the control variables. Again, we saw that "team trust" had a significant indirect effect on "team performance" mediated by "TWE" ($\beta = .223, p < .01$), but no such effect was observed for "team autonomy". As no control variable had either a significant direct or indirect effect on the dependent variables and the effects from Step 2 stayed significant (Table 4), we concluded that the findings could not be attributed to the properties of the particular teams. The overall conclusion from the analysis is that both "team autonomy" and "team trust" may function as team work resources, affecting

"team work engagement" and eventually "team performance". However, "team autonomy" as a work resource seems to have a weaker effect than "team trust". Finally, all VIF values in the model ranged between 1.017 and 1.754, which is lower than the threshold of 3 recommended by Hair et al. [39] for PLS-SEM. This, in combination with other reliability diagnostics, indicates that the findings are not solely due to the measurement method.

5   Discussion

Team autonomy and team trust have long been acknowledged as fundamentals of agile teams [1, 3]. Our study indicates that these factors do not directly affect the performance of such teams but instead may affect team work engagement. Further, team work engagement seems to have a strong effect on team performance, thus indirectly linking it back to trust and - to a smaller extent – to team autonomy. In this way, our results confirm that work engagement is significant for the performance of agile teams [5, 6]. The results are summarized in Table 6.

Table 6. Summary of the results and implications

Hypothesis	Findings
H1: Team autonomy → Team work engagement	Partially supported. High autonomy can lead to engagement in teams, but this effect is weakened when trust is considered
H2: Team trust → Team work engagement (TWE)	Supported. Teams with high trust are likely to be highly engaged in their work. Trust shows a stronger relationship with TWE than team autonomy
H3: TWE → Team performance	Supported. TWE is positively related to team performance. Highly engaged teams perceive their performance higher than the teams with lower engagement
H4: TWE mediates Team autonomy → Performance	Partially supported. Team work engagement mediates the relationship between team autonomy and team performance, but the effect is eliminated when trust is controlled for
H5: TWE mediates Team trust → Performance	Supported. Team work engagement mediates the relationship between team trust and team performance, indicating an indirect effect of trust on perceived team performance

The absence of the direct effect of autonomy on performance and its weakened effect on team work engagement may sound surprising as autonomy consistently has been described as one of the fundamental needs of agile teams [1] and also one of the key characteristics in many work-stress models and theories (e.g., [26]). However, the

strength of the relationship between autonomy and work engagement has been found to vary across studies [20]. This can partially be explained by the so-called autonomy paradox, meaning that greater autonomy can have both positive (e.g., increased control over tasks) and negative effects (increased stress due to increased job demands and expectations of their contribution to organizational performance) [22]. We follow Hakanen et al. [20], suggesting that the engaging power of autonomy is not so straightforward in the context of agile teams with complex tasks and organizational contexts.

Our findings indicate that team trust plays an important role in fostering work engagement and further enhancing team performance in agile teams. This is in line with the proposition of Moe et al. that mutual trust is of fundamental importance for agile teams and that teams that had not established mutual trust use more time on discovering and acknowledging issues [3]. Another explanation for our findings is the possible interaction between autonomy and trust. Our results indicate that the level of trust may impact the effect of team autonomy on engagement and performance. This corresponds to the findings in our recent study [43], showing that team autonomy positively affects psychological safety, a distinct but related construct of trust. Other studies also highlight lack of trust as one of the potential barriers to team autonomy [44]. We, therefore, invite researchers to further investigate whether and how team trust and team autonomy interact to affect the level of engagement in agile teams.

6   Limitations and Future Work

While providing valuable contributions to the literature, this study also has some limitations. First, the research model in our study is confined to a limited number of team-level factors influencing team work engagement and team performance. The reality for teams in organizations is obviously much more complex, with a daunting number of other factors, both on the individual, team, and organizational level, that impact the work and performance. The present study examines how job resources (trust, autonomy) and work engagement relate to the performance of agile software development teams and is a first step in understanding the factors impacting teams' engagement and performance in this setting. We acknowledge that there are several organizational and technical factors that could impact the engagement and performance of software development teams. Forsgren, Humble, and Kim [45], for instance, identified 24 capabilities that drive software delivery performance, including organizational culture, leadership, and architectural aspects. We thus encourage researchers to test more complex research models to further explore the effect of job resources at different levels that are relevant for the engagement and performance of agile software development teams. Second, the cross-sectional nature of our data does not allow us to conclude causality between the variables (for example, that work engagement leads to better team performance or vice versa). We are thus left with only indications of causality derived from theory and previous research. Future research should be conducted using a time-lagged design in order to examine the causal relationships between team autonomy and team work engagement; and team work engagement and performance. Further, self-reported data was the only foundation of the study. For example, we did not apply external actors' evaluation of the teams' performance, which may have biased the performance scores. Still, we believe that a strong relationship

between teams' trust and work engagement; and between work engagement and their own perception of performance is a valuable result that deserves further investigation. We invite researchers to validate whether this result holds when additional measures of performance are also applied. Finally, the self-reported data may have inflated the correlations among the variables and thus potentially suffer from Common Method Bias (CMB). However, pre-existing measures were used, and statistical procedures for PLS-SEM were undertaken to reduce the risk of CMB.

7 Implications and Conclusion

Our results provide valuable theoretical insights and also have important practical implications for agile teams. The study demonstrates the theoretical value that the JD-R model and the work engagement literature can provide for agile research. Work engagement is a meaningful construct at the team level that mediates the impact of job resources on performance in teams. The overall results indicate that highly engaged teams are also likely to perform their tasks more efficiently and effectively, thus generating a competitive advantage. Agile practitioners should therefore promote team-based resources that contribute to engagement in their teams. Our findings suggest that both increasing the level of autonomy and, more importantly, building trust in the teams can foster team engagement, which in its turn has the potential to enhance the performance of agile teams. The "social fabric" of the teams plays an important role for team engagement and performance probably because succeeding in agile software development teams requires honest feedback, communication and collective problem-solving. We, therefore, urge practitioners to provide opportunities for teams to build trusting relationships where team members can demonstrate their competence, integrity, and benevolence.

References

1. Moe, N.B., Dingsøyr, T., Dybå, T.: Understanding self-organizing teams in agile software development. In: 19th Australian Conference on Software Engineering (ASWEC 2008), pp. 76–85 (2008). https://doi.org/10.1109/ASWEC.2008.4483195
2. Mohagheghi, P., Lassenius, C., Bakken, I.O.: Enabling team autonomy in a large public organization. In: Paasivaara, M., Kruchten, P. (eds.) XP 2020. LNBIP, vol. 396, pp. 245–252. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-58858-8_25
3. Moe, N.B., Dingsøyr, T., Dybå, T.: A teamwork model for understanding an agile team: a case study of a Scrum project. Inf. Softw. Technol. **52**, 480–491 (2010)
4. Bakker, A.B., Demerouti, E.: Towards a model of work engagement. Career development international (2008)
5. Sharp, H., Baddoo, N., Beecham, S., Hall, T., Robinson, H.: Models of motivation in software engineering. Inf. Softw. Technol. **51**, 219–233 (2009). https://doi.org/10.1016/j.infsof.2008.05.009

6. Murphy-Hill, E., et al.: What predicts software developers' productivity? IEEE Trans. Software Eng. **47**, 582–594 (2021). https://doi.org/10.1109/TSE.2019.2900308
7. Torrente, P., Salanova, M., Llorens, S., Schaufeli, W.B.: Teams make it work: how team work engagement mediates between social resources and performance in teams. Psicothema **24**, 7 (2012)
8. Huck-Fries, V., Prommegger, B., Wiesche, M., Krcmar, H.: The role of work engagement in agile software development: investigating job demands and job resources. In: Hawaii International Conference on System Sciences 2019 (HICSS-52) (2019)
9. Hoda, R., Murugesan, L.K.: Multi-level agile project management challenges: a self-organizing team perspective. J. Syst. Softw. **117**, 245–257 (2016). https://doi.org/10.1016/j.jss.2016.02.049
10. Fowler, M., et al.: Principles behind the Agile Manifesto (2001). http://agilemanifesto.org/principles.html
11. Schaufeli, W.B., Salanova, M., Lez-Roma, V.G., Bakker, A.B.: The measurement of engagement and burnout: a two sample confirmatory factor analytic approach. J. Happiness Stud. **3**, 24 (2002)
12. Mazzetti, G., Robledo, E., Vignoli, M., Topa, G., Guglielmi, D., Schaufeli, W.B.: Work engagement: a meta-analysis using the job demands-resources model. Psychol. Rep. (2021). https://doi.org/10.1177/00332941211051988
13. Costa, P., Passos, A.M., Bakker, A.: Empirical validation of the team work engagement construct. J. Pers. Psychol. **13**, 34–45 (2014). https://doi.org/10.1027/1866-5888/a000102
14. Bakker, A.B., Demerouti, E.: Job demands–resources theory: taking stock and looking forward. J. Occup. Health Psychol. **22**, 273–285 (2017). https://doi.org/10.1037/ocp0000056
15. Demerouti, E., Bakker, A.B., Nachreiner, F., Schaufeli, W.B.: The job demands-resources model of burnout. J. Appl. Psychol. **86**, 499–512 (2001). https://doi.org/10.1037/0021-9010.86.3.499
16. Ryan, R.M., Deci, E.L.: Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am. Psychologist. **11** (2000)
17. Christian, M.S., Garza, A.S., Slaughter, J.E.: Work engagement: a quantitative review and test of its relations with task and contextual performance. Pers. Psychol. **64**, 89–136 (2011). https://doi.org/10.1111/j.1744-6570.2010.01203.x
18. Muller, D., Kropp, M., Anslow, C., Meier, A.: The effects on social support and work engagement with scrum events. In: 2021 IEEE/ACM 13th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE), pp. 101–104. IEEE, Madrid (2021). https://doi.org/10.1109/CHASE52884.2021.00019
19. Rietze, S., Zacher, H.: Relationships between agile work practices and occupational well-being: the role of job demands and resources. IJERPH **19**, 1258 (2022). https://doi.org/10.3390/ijerph19031258
20. Hakanen, J.J., Bakker, A.B., Turunen, J.: The relative importance of various job resources for work engagement: a concurrent and follow-up dominance analysis. BRQ Bus. Res. Q. (2021). https://doi.org/10.1177/23409444211012419
21. Halbesleben, J.R.: A meta-analysis of work engagement: relationships with burnout, demands, resources, and consequences. In: Bakker, A.B., Leiter, M.P. (eds.) Work Engagement: A Handbook of Essential Theory and Research, pp. 102–117 (2010)
22. Palumbo, R.: Engaging by releasing: an investigation of the consequences of team autonomy on work engagement. TPM **27**, 425–445 (2021). https://doi.org/10.1108/TPM-03-2021-0021
23. Langfred, C.W.: Autonomy and performance in teams: the multilevel moderating effect of task interdependence. J. Manag. **31**, 513–529 (2005). https://doi.org/10.1177/0149206304272190

24. Muecke, S., Linderman-Hill, K., Greenwald, J.M.: Linking job autonomy to work engagement: the mediating role of challenge demands. Proceedings **2020**, 13553 (2020). https://doi.org/10.5465/AMBPP.2020.13553abstract
25. Hackman, J.R., Oldham, G.R.: Motivation through the design of work: test of a theory. Organ. Behav. Hum. Perform. **16**, 250–279 (1976). https://doi.org/10.1016/0030-5073(76)90016-7
26. Theorell, T., Karasek, R.A.: Current issues relating to psychosocial job strain and cardiovascular disease research. J. Occup. Health Psychol. **1**, 9 (1996)
27. Buvik, M.P., Tvedt, S.D.: The impact of commitment and climate strength on the relationship between trust and performance in cross-functional project teams: a moderated mediation analysis. TPM **22**, 114–138 (2016). https://doi.org/10.1108/TPM-02-2015-0011
28. Buvik, M.P., Tvedt, S.D.: The influence of project commitment and team commitment on the relationship between trust and knowledge sharing in project teams. Proj. Manag. J. **48**, 5–21 (2017). https://doi.org/10.1177/875697281704800202
29. Mayer, R.C., Davis, J.H., Schoorman, F.D.: An Integrative model of organizational trust. Acad. Manag. Rev. **20**, 709 (1995). https://doi.org/10.2307/258792
30. Hakanen, J.J., Bakker, A.B., Schaufeli, W.B.: Burnout and work engagement among teachers. J. Sch. Psychol. **43**, 495–513 (2006). https://doi.org/10.1016/j.jsp.2005.11.001
31. Chen, G., Kanfer, R.: Toward a systems theory of motivated behavior in work teams. Res. Organ. Behav. **27**, 223–267 (2006). https://doi.org/10.1016/S0191-3085(06)27006-0
32. Costa, P., Passos, A.M., Bakker, A.B.: Direct and contextual influence of team conflict on team resources, team work engagement, and team performance. Negot. Confl. Manage Res. **8**, 211–227 (2015). https://doi.org/10.1111/ncmr.12061
33. Schaufeli, W.B., Bakker, A.B.: Defining and measuring work engagement: bringing clarity to the concept. In: Work Engagement: A Handbook of Essential Theory and Research, pp. 10–24. Psychology Press, New York (2010)
34. Costa, A.C., Anderson, N.: Measuring trust in teams: development and validation of a multi-faceted measure of formative and reflective indicators of team trust. Eur. J. Work Organ. Psy. **20**, 119–154 (2011). https://doi.org/10.1080/13594320903272083
35. Schaufeli, W.B., Shimazu, A., Hakanen, J., Salanova, M., De Witte, H.: An ultra-short measure for work engagement. Eur. J. Psychol. Assess. **35**, 1–15 (2017)
36. Jehn, K.A., Northcraft, G.B., Neale, M.A.: Why differences make a difference: a field study of diversity, conflict and performance in workgroups. Adm. Sci. Q. **44**, 741–763 (1999)
37. Chan, D.: Functional relations among constructs in the same content domain at different levels of analysis: a typology of composition models. J. Appl. Psychol. **83**, 234 (1998)
38. LeBreton, J.M., Senter, J.L.: Answers to 20 questions about interrater reliability and interrater agreement. Organ. Res. Methods **11**, 815–852 (2008). https://doi.org/10.1177/1094428106296642
39. Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., Danks, N.P., Ray, S.: Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-80519-7
40. Zhao, X., Lynch, J.G., Jr., Chen, Q.: Reconsidering Baron and Kenny: Myths and truths about mediation analysis. J. Consum. Res. **37**, 197–206 (2010)
41. Kock, N.: Common method bias in PLS-SEM: a full collinearity assessment approach. Int. J. e-Collab. (IJEC) **11**, 1–10 (2015)
42. Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., Podsakoff, N.P.: Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Psychol. **88**, 879–903 (2003). https://doi.org/10.1037/0021-9010.88.5.879
43. Buvik, M., Tkalich, A.: psychological safety in agile software development teams: work design antecedents and performance consequences. Presented at the Hawaii International Conference on System Sciences, 4 January 2022 (2022). https://doi.org/10.24251/HICSS.2022.880

44. Moe, N.B., Stray, V., Hoda, R.: Trends and updated research agenda for autonomous agile teams: a summary of the second international workshop at XP2019. In: Hoda, R. (ed.) XP 2019. LNBIP, vol. 364, pp. 13–19. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-30126-2_2

45. Forsgren, N., Humble, J., Kim, G.: Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations. IT Revolution (2018)