

Teamwork and Project Success in Agile Software Development Methods: A Case Study in Higher Education

Lina Lukusa

Department of Information Systems, University of Cape
Town, Cape Town, South Africa
Linalukusa@gmail.com

Shallen Lusinga

Department of Information Systems, University of Cape
Town, Cape Town, South Africa
Shallen.lusinga@uct.ac.za

Sharon Geeling

Department of Information Systems, University of Cape
Town, Cape Town, South Africa
Sharon.geeling@uct.ac.za

Ulrike Rivett

Department of Information Systems, University of Cape
Town, Cape Town, South Africa
Ulrike.rivett@uct.ac.za

ABSTRACT

Teamwork is vital for agile projects' success from project inception to delivery. Despite the importance of teamwork within agile development teams, little is known about how teamwork affects agile teams within the higher education environment. This research studied the case of honors students in Information Systems from the University of Cape Town by testing the relationship between teamwork, team members' success, and team performance. Simple linear regression analysis was followed to determine teamwork's influence on team members' success and team performance. The results show that teamwork possesses a strong positive relationship with team members' success and a medium positive relationship with team performance. These findings confirm the vital role of teamwork in agile teams to achieve successful team performance and team members' success. This research contributes to the body of knowledge regarding the influence of teamwork in agile software methods in the higher education environment. Understanding such a relationship will help students recognize the importance of teamwork in delivering a good product that will benefit their grades. Moreover, it would contribute to a better design of curriculums for the Information Systems discipline.

CCS CONCEPTS

• **Human-centered computing**; • **Collaborative and social computing**; • **Collaborative and social computing theory, concepts and paradigms**; • **Collaborative content creation**;

KEYWORDS

Agile Methods, Teamwork, Project Success, Higher Education Environment, Team Members Success, Team Performance

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1 INTRODUCTION

Teamwork is part of the agile manifesto's essential principles, a statement published by seven agile methodologists containing a description of agile software development methods [2]. Agile software methods refer to the constant readiness of a software development method to inherently and quickly create change and embrace that change reactively and proactively [12]. Agile software methods are all about how software development teams plan, communicate, and coordinate their work [5]. The methods are based on the principles that individual interactions are more vital than tools and processes [12]. These principles focus on factors such as communication, team collaboration, team motivation, and team management [6]. Agile software methods focus on the people factors in a project comprising talent, values, trust, willingness to learn, skills, and more [12]. Successful delivery of agile necessitates teamwork that possesses a greater sense of collective ownership, in which each person can replace another without any issues [12].

Many studies have explored teamwork's effect on team members' success and team performance in the commercial context [8, 11, 22]. Despite growing studies, the exploration of teamwork's influence on team performance and team members' success in the educational context has received little attention. The commercial context differs from the educational context because it values first the employees' knowledge as the dictum says, "knowledge is power" [16]. In this context, knowledge does not indicate only the diplomas of formal college but also the knowledge gained from experience. The commercial context comprises agile practitioners who might not possess college diplomas but possess knowledge of how agile is conducted, making them efficient [16]. In the educational context, learners must have some common understanding and diplomas to work on an agile project [20]. Learners share the same experience and are tested with the same scale [20].

Students need to successfully work in teams to deliver a good agile project and get good grades. A better understanding of the

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teamwork contribution to project success can contribute to improvements in students' grades and provide insight into the higher education curriculum's appropriate design. In light of these considerations, the need to investigate teamwork in agile software methods within the higher education environment is important. This project's main research question was: *What is the influence of teamwork on team members' success and team performance in agile software projects in the higher education environment?* By answering this question, we seek to highlight how teamwork impacts team performance and team members' success while university students are working on a quasi-real-world project.

2 LITERATURE REVIEW

2.1 Agile Software Methods

Agile software methods started in the 1990s as a reaction to weaknesses of historical software development methods such as the waterfall methods [14]. The waterfall methods have been criticized for failing to involve all team members during project planning, being inflexible, missing deadlines, and failing to meet customer needs [14]. In contrast, agile software methods bring a set of guidelines that allow rapid adaptations to match the needs that emerge during product development [14]. They are characterized by collaboration and communication between team members and continuous interaction with the customer and product at every step of the development project [13].

Successful delivery of an agile project requires teamwork to develop a greater sense of collective ownership, where each person can replace another without any issues [12]. Team members need to work closely together, have frequent communication, value other team members' work and efforts, and shift the workload between them [13].

2.2 Teamwork in Agile Software Methods

The word "teamwork" refers to a group's willingness to pursue a common cause in a climate of mutual aid and spontaneous cooperation [18]. The French language owns a beautiful phrase for teamwork: *esprit de corps* [9]: the spirit of a group that creates the desire to succeed amongst all the members because they have a strong sense of enthusiasm and pride in sharing the team's aim [18]. It means that members learn skills from one another, receive support from their peers, and respect and value each other's contributions [9]. Teamwork fosters a sense that unity is strength within each member; therefore, more can be accomplished working together than as individuals [9].

Teamwork in agile software methods must be democratic and flexible [1, 4]. It does not have to possess a strict hierarchy, and all team members must be peers at the same level. They need to switch roles and leadership to gain new knowledge and experiences. Team members must deal with complex and interdependent responsibilities and share expertise and knowledge [4]. Members must use a rational decision-making process throughout the development of the project [4]. Research on teamwork in agile software methods indicates that every team member needs to be empowered with cross-functional skills and collective decision-making [1]. The cross-functional team means that the team's leadership is subject to change depending on the requirements of an iteration in progress

at the time [4]. [18] state that it might be challenging to rotate team member roles since some tasks require highly experienced and skilled people. Expertise sharing through collaboration and communication requires members to have a high level of mutual trust among them. In contrast, [12] observe that team members would be forced to acquire similar skills and experience since agile software methods offer a flexible relationship that promotes and supports members' internal learning process. Interaction between the most competent and experienced team members with the less skilled ones will enhance everyone's ability [11].

2.3 Teamwork Success Factors

Teamwork involves important considerations that guide the effective implementation of agile projects [11]. This study identified six key factors that aim to develop a more parsimonious path to effective teamwork practices in agile software methods, which are: communication, effort, mutual support, coordination, team cohesion, and mutual contribution [11]. These factors have been selected for use in this study due to the empirical evidence showing their impact on project success and the predominance of theoretical literature [3, 8, 11]

2.3.1 Communication. Communication is the exchange of information between people [8].

[8] state that communication quality within a team is essential. It can be described in terms of frequency, formalization, and openness of the information exchanged. Frequency refers to how often or extensively the team communicates, such as the time spent communicating [8]. The higher the frequency of communication, the more productive the project will be [8]. Formalization refers to how spontaneously every team member can communicate with others [11]. It relates to informal communication like quick phone calls, talks in the hallway, short emails. In contrast, formal communication necessitates a large amount of preparation and planning before it can happen, such as scheduled meetings [11]. Informal discussion is crucial in agile software methods for effective teamwork to take place. It helps share, evaluate, and discuss ideas and contributions with other team members more efficiently and quickly [8]. It is also crucial for communication quality that each team member shares information openly with each other [11]. Placing team members close together is essential to stimulate open and informal communication [3]. Lack of open communication may hinder knowledge sharing [3].

2.3.2 Effort. Team members should prioritize and do their best to support the team's tasks [11]. It is challenging to complete the team goals in agile software methods if team members do not put effort and are not committed to the team [12]. All team members should contribute to the project, express their opinions about any problems, and support each other [7].

2.3.3 Mutual Support. Teamwork is founded on mutual support rather than competition between team members [21]. Mutual support improves the quality and acceptance of ideas between team members and increases cooperation [11]. It is an essential mechanism of teamwork that enables the team to accomplish its goals. The better the team supports each other, the more efficient and effective its success will be [11].

2.3.4 Coordination. Coordination refers to the management of dependencies between activities [11]. Such dependencies comprise task assignments, shared resources, tasks, and subtask relationships, and they are often assigned to individual members [11]. Synchronization and harmonization of these activities are crucial for teamwork and project success [11]. The management of dependencies requires feedback because it is impossible for teams to identify all dependencies before the beginning of works [11]. Team members should ensure effective coordination of expertise. It will enable positive teamwork results, while its breakdown can lead to misunderstandings, increased errors, and derail performance [18].

Agreement on mutual structures within a team is crucial [11]. It helps to break down schedules, effort, and work required for the tasks [11]. The result will be maximized effort and contributions of each individual and prevent any redundancies that may occur. However, the structure should remain flexible to tackle any unpredicted events that can arise [8]. Unexpected events are obvious because software product development involves ambiguous, ill-defined, up-front planning, and nonroutine work [11]. Frequent feedback on coding standards and work products is also part of coordination practice, and it is essential to the team [3]. Coordination can be done via a mutual review, planning, and retrospective meetings for each iteration and short meetings [3].

2.3.5 Team Cohesion. Cohesion refers to team members' tendency to stick together and stay united when pursuing their shared goals and objectives [11]. Team cohesion is important to achieve teamwork as agile software method values individuals and their interactions over processes and tools [11].

[21] argue that cohesion possesses two dimensions; the sense of morale and the feeling of belonging. Usually, team members may dislike associating themselves with other members if they do not have a feeling of morale. Similarly, if a team lacks a sense of belonging, it may lack the motivation to realize organizational objectives and goals. [8] found out that high-quality teamwork can be accomplished without the presence of a sense of belonging and a need to keep the team going and stay on it.

2.3.6 Balanced Contribution. A balanced contribution of every member is critical for successful teamwork because members have knowledge in various fields such as graphical user interface (GUI) development, core development, testing, system architecture, etc. [11]. The contribution of team members' task-relevant expertise and knowledge is important for the team's decision-making process [8]. It is also beneficial in quick resolution and management of conflicts, respect for contributions and suggestions made by other members, constructive discussions, and good cooperation [11]. Thus, it is important for team members to be self-organized to manage effectively issues and other conflicts that may arise [3].

2.4 Project Success

Many studies argue that project success in agile software methods can be achieved through teamwork [4, 8, 11]. A study conducted by [11], with 71 teams from 26 companies recruited at the Norwegian Agile Conference, proved that teamwork significantly affects project success. However, [8] argue that teamwork is not the single cause for project success. They propose other elements such

as management and organizational factors and say that external causes might also play a key role in influencing project success. The evaluation of project success can vary across stakeholders, team members, and leaders, making it challenging to assess project success objectively [8]. For this study, the definition of project success is based on two people-related outcomes: team performance and team members' success.

2.4.1 Team Performance. Team performance refers to how a team can meet the required time, quality, and cost objectives of a project [11]. The time element is the scheduling of works and completion dates, whereas quality refers to how well the end product functions [11]. Cost is the total cost of the project [4]. According to [4], a project is successful if completed on time, according to the required quality, and within the budget [4].

Team performance comprises two key subconstructs: efficiency and effectiveness [8]. Efficiency is the extent to which expectations concerning the *project quality* are met [11]. Efficiency is often evaluated in terms of schedule and budget [11]. While effectiveness is the extent to which expectations about the *product quality* are met [11]. Effectiveness involves aspects like reliability, functionality, robustness, and performance [2].

2.4.2 Team Members' Success. Team members' success refers to individual-related outcomes such as team viability [11]. It can occur if every member works to enhance each other's motivation and ability to be involved in future teamwork [21]. Team members' success is a critical factor that increases individuals' motivation to work on future projects with the same team [11].

[8] argue that team members' success can be defined in terms of work satisfaction and learning. Work satisfaction is achieved when a team had full ownership of the project's realization, every team member who worked on the project was proud of what he did, is still happy that he worked on that project, and understood what needed to be done [4]. It is evaluated as positive if, after the project, team members still desire to do the same type of collaboration again in the future [11]. Learning enhances expertise, skills and improves effectiveness, job satisfaction, and performance [3]. It is an ongoing process of action and reflection, where learners ask questions, obtain feedback, run the project, reflect on results, and discuss unpredicted outcomes of actions or errors [4]. Learning is considered to be a contribution to a project's successful outcome and not a part of the outcome itself [11]. The retrospective meeting is significant to assess each member's success. A retrospective meeting helps the team to go through what went wrong and analyze any issue during the project development to improve things in the future [4].

3 CONCEPTUAL MODEL

This study replicated the conceptual model developed by [8] concerning teamwork's effect on project success, but it shifted the focus from commercial context to the educational context. The commercial context differs from the educational context because in the commercial environment there is more focus on the knowledge and experience of employees [16]. The commercial environment is looking for agile practitioners who might not always possess college diplomas but possess knowledge of how agile is conducted

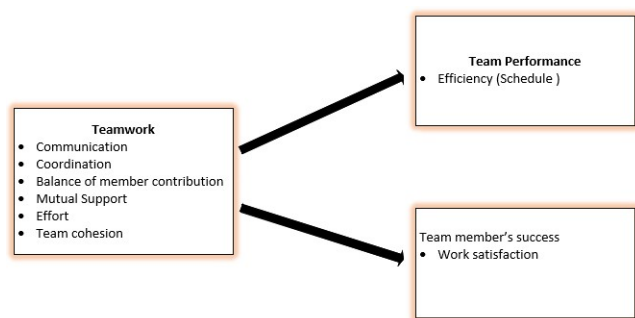


Figure 1: Conceptual Model [8]

Table 1: Teamwork Subconstructs [11].

Communication	Spontaneous communication, less formal, talking or chatting in front of the screen, talking the doorway.
Coordination	Self-organizing teams, teams make decisions. Not strong leadership, define priorities and delegates tasks.
Balance of Member Contribution	In cross-functional, all team members are expected to contribute to the workload.
Mutual Support	Collective code ownership stimulates mutual support through retrospective meetings.
Effort	Focus on the team's objective and not tasks outside the team.
Cohesion	Focus on the interaction among team members.
Team performance: Efficiency	The team's extent meets expectations about adherence to schedule, cost, time, and adherence to budget.
Team Members' success: Work Satisfaction	Extent to which team members are motivated to work in future similar projects.

[16]. Common knowledge, as well as diplomas, characterize learners of agile within the educational environment. They share the same experience and are tested with the same scale [20].

The conceptual model investigated teamwork's effect on two team outcomes: team performance and team members' success, as shown in Figure 1 below. Teamwork is the independent variable, while team performance and team members' success are dependent variables because their outcomes are influenced by teamwork [8]. For this research project, team performance is described in terms of efficiency. Team members' success is defined in terms of work satisfaction [8]. Effectiveness and learning have been left out of the conceptual model because of scope constraints.

A brief explanation of the above theoretical framework is described in table 1 below [11]:

According to [11], teamwork positively relates with team performance and team members' success. [8] argue that good teamwork

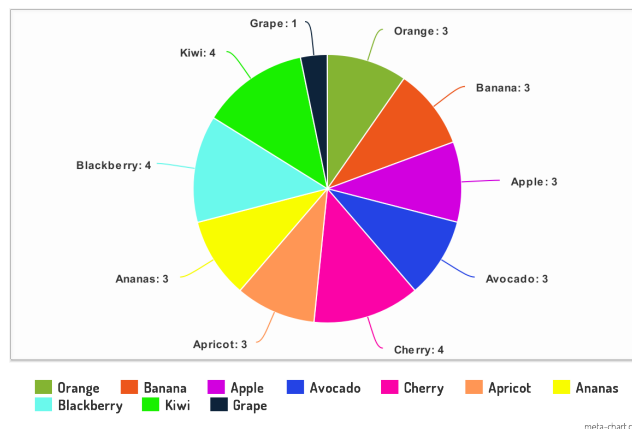


Figure 2: UCT IS Honors Teams for Agile Method

leads to team members being satisfied with their work situation and impacts the performance of innovation teams. Research by [11], involving 477 respondents from 71 agile software teams in 26 organizations shows that teamwork influences both team performance and members' success. The study by [16] confirms these results. Considering these theoretical considerations and empirical evidence, the following hypotheses are proposed:

Hypothesis 1

The first hypothesis was developed to test the relationship between teamwork and team performance.

H1₀: Teamwork does not influence team performance.

H1₁: Teamwork does influence team performance.

Hypothesis 2

The second hypothesis was developed to test the relationship between teamwork and team members' success.

H2₀: Teamwork does not influence team members' success.

H2₁: Teamwork does influence team members' success.

4 RESEARCH METHOD

4.1 Sampling

This study's sample population was honors students in Information Systems (IS) at the University of Cape Town (UCT). It was an appropriate sample for this study as the students in this program were learning how to implement the agile method. Students formed teams and applied the agile software method to different real-world projects allocated to them by various companies. The projects assigned to the different teams were to be delivered to the companies within nine months. The teams consisted of at least three to four members, and members considered themselves a team. This study's sample size was ten agile teams that possessed a close relationship with the phenomenon under investigation. Each team was given pseudonyms to preserve confidentiality. Figure 2 below provides a graphical representation of the different teams and shows the number of responses received from each team.

4.2 Data Collection and Cleaning

A questionnaire was used to collect data because questionnaires can easily be standardized and used for comparisons [19]. This

Table 2: Descriptive statistics of the investigated variables. *On a scale which 1 is strongly disagree, and 5 is strongly agree.

Constructs	Variable	No of Itemson the survey	Mean	Standard Deviation
Teamwork	Communication	9	3,33	0,48
	Coordination	4	3,45	0,54
	Cohesion	10	3,49	0,70
	Balance of	3	3,89	0,48
	Member Contribution			
Team Member's Success	Mutual Support	7	3,90	0,84
	Work satisfaction	4	3,83	1,05
Team Performance	Efficiency	3	3,37	1,052

is important as this study looked to standardize responses from different teams and compare them. The questionnaire used to collect data was developed using questions adapted from the study by [11] who look at the agile software method in a commercial context. For this study, the questionnaire was adapted to fit the educational context. The questionnaire captured demographic information and the variables that measure teamwork, team members' success, and team performance. The items in the questionnaire were measured on a 5-point Likert scale where 1 represented strongly disagree and 5 represented strongly agree.

4.3 Research Findings and Analysis

4.3.1 Descriptive Statistics. This research study considered responses only from nine teams or twenty-nine individual responses in total. The teams that have been selected comprised a minimum of three and a maximum of four team members. The team that has been rejected was team grape because it provided only one response. Team Kiwi had a duplicated response that was identified and removed, leaving three responses for team Kiwi.

The descriptive statistics for the eight variables used to measure teamwork, team performance, and team members' success is presented in Table 2 below. Each variable is represented as the arithmetic mean of the individual items that comprise the variable.

Table 2 above shows that between all of the variables, on a scale of 1 strongly disagree to 5 strongly agree, mutual support, the investigated variable of teamwork, had the largest effect with its mean value equal to 3,90. This indicates that the respondents largely agreed with the variables used to measure mutual support. It also means that a constructive discussion, rapid resolution of conflicts, good cooperation, respect for contributions and suggestions made by other team members, and the ability to reach consensus are considered particularly essential in agile teams. Mutual support is also essential in agile teams since agile teams are asked to be self-organized; no leader can manage issues and deal with agile teams' conflicts. Thus, each team member should have the ability to step in and fulfill any unexpected issue that may arise and support each other [1].

The effort received the smallest mean (3,28) comparing to all other variables. This means that team members' effort into the deliverable of the project tended to be less. This outcome can be

Table 3: Reliability Testing.

Constructs	Cronbach's Alpha
Teamwork	0,90
Team Performance	0,88
Team Members Success	0,91
All Constructs	0,94

explained by the fact that agile projects are being conducted within the educational environment. Students are expected to meet the deadlines of other deliverables [12]. Therefore, some students may have developed their strategic deadlines individually and worked in isolation [12].

4.3.2 Reliability Testing. Cronbach's alpha was measured at the team level, which is on aggregated values to test this study's reliability. Table 3 below represents the Cronbach's alpha for teamwork, team performance, and team members' success. A Cronbach's alpha of at least 0.7 is usually required [15]. Therefore, all variables were satisfactory because the Cronbach's Alpha was above 0.7 for all the constructs.

4.3.3 Hypothesis Testing. To test the proposed hypotheses, simple regression analysis was conducted in this study. In regression analysis, the p-value is an indicator used to evaluate significance levels. [10] indicates that the required p-value to accept a hypothesis must be lower 0.05 (<0.05) for the variable to be considered as significant.

Hypothesis 1: Teamwork influences Team Members' Success

Figure 3 below reveals the results of a simple linear regression analysis that tests whether teamwork is related to success. The p-value was less than 0,05 ($p < 0,00000$). R^2 represents the percentage of variance for a dependent variable explained jointly or uniquely by an independent variable [19]. R^2 is equal to 0,80480050, meaning that teamwork has a large effect on team members' success. Therefore, the alternate hypothesis was accepted; teamwork is related to team members' success.

Hypothesis 2: Teamwork Influences Team Performance

Another regression analysis was conducted to test the second hypothesis. The results of the analysis are shown in Figure 4

N=29	R= ,90098386 R ² = ,81177191 Adjusted R ² = ,80480050 F(1,27)=116,44 p<,00000 Std.Error of estimate: ,47082					
	b*	Std.Err.	b	Std.Err.	t(27)	p-value
Intercept			-	0,594956	-4,28380	0,000208
Teamwork	0,900984	0,083495	1,80407	0,167185	10,79088	0,000000

Figure 3: Summary of Regression for Dependent Variable: Relationship between Teamwork and Team Member Success.

N=29	R= ,70028613 R ² = ,49040066 Adjusted R ² = 0,47152661 F(1,27)=25,983 p<,00002 Std.Error of estimate: ,76628					
	b*	Std.Err.	b	Std.Err.	t(27)	p-value
Intercept			1,54893	0,968320	1,59961	0,121324
Teamwork	0,700286	0,137383	1,38699	0,272101	5,09733	0,000023

Figure 4: Summary of Regression for Dependent Variable: Relationship between Teamwork and Team Performance Efficiency.

The p-value was less than (0,05) ($p < 0,00002$) and R^2 is equal to 0,47152661. The alternate hypothesis was thus accepted; teamwork is related to team performance.

4.3.4 Results. This study's statistical results indicated a positive influence of teamwork on team members' success and team performance. Teamwork had a strong association with team members' success ($R^2 = 0,80480050$). The result indicates that teamwork in agile projects determines team members' success with their work situation to a large degree. Also, teamwork has a medium positive effect on team performance ($R^2 = 0,47152661$). Interestingly, these results are consistent with prior studies conducted in the commercial context by [8, 11, 22].

4.4 Discussion

The strong association between teamwork and team members' success indicated that teamwork determines team members' contentment with their work situation to a great degree. Similarly, [11] argue that team members tend to rate team success high if they have engaged in healthy internal processes, such as a quick resolution of conflicts and good teamwork.

Teamwork had about 47% of the variance ($R^2 = 0,47152661$) in the rating of team performance. It indicates the explanatory power of teamwork, thus leaving a bigger part of the unexplained variance in team performance. Teamwork, as an influence on team performance, but it cannot account for team performance [8]. Other characteristics of project management, such as applying the required skills to perform a project, accurate planning, controlling a project, and factors such as resource scarcity, may be essential predictors of teams' performance as well [8]. Furthermore, a trade-off between the project's quality and the time required to deliver the project plays an essential role in agile projects, especially in the educational environment context [12]. If students consider the project quality to

be the most important, they will emphasize on teamwork. However, if meeting expectations concerning the time the project has to be delivered is their principal focus, teamwork may be less important for them [11, 12]. This can confirm the medium association between teamwork and team performance ($R^2 = 0,47152661$).

This research study highlighted that good teamwork can be captured through the six sub-constructs (communication, cohesion, mutual support, effort, balance of member contribution, and coordination). This finding aligned with the studies conducted by [3, 8]. The six sub-constructs of teamwork refer to the quality of interaction and collaboration within teams. Both team members' success and team performance are positively connected to teamwork when the six sub-constructs are applied effectively by team members. The sub-constructs are a way to ensure good teamwork within different agile projects [8]. Also, this study offers IS students and teachers a way to evaluate teamwork and reflect on it.

4.5 Conclusion

Existing literature indicates the effect that teamwork has on team performance and team members' success. More studies have explored this effect from a commercial point of view. This study explored the effects of teamwork in the educational context.

The statistical result showed that teamwork influence is positive on both team members' success and team performance. These results were consistent with those in the extant literature. Also, it indicated that the different sub-constructs (communication, cohesion, mutual support, effort, the balance of member contribution and coordination) are important in teamwork. The use of sub-constructs can serve as a tool for higher education institutions and IS students to enhance collaboration and interaction within agile projects effectively. The finding of this study also showed that teamwork significantly impacts team members' success, but it does not largely affect team performance. This is because other project management factors, such as planning and controlling are also playing a key role in the delivery of successful projects [8].

This systematic exploration of teamwork and project success in a higher education environment contributes to the field of agile software methods by providing a consolidated view of teamwork factors and its dependencies in this context. Thus, this contribution can help the IS discipline design their curriculum and students in improving their interaction to achieve personal and project success.

4.6 Limitations and Recommendations for Future Work

Like many studies, this research study had several limitations that should be noted. The sample size of this study was small (29 respondents) for a quantitative research. As [17] proposes that quantitative research should have 30 respondents as the minimum. Due to this empirical report's scope and time constraint, learning and effectiveness were not included in the conceptual model. This research study was aimed to be submitted for examination before completing the agile project the respondents were developing. Another limitation was that every university has its own culture or way of doing agile projects and interpreting agile software methods. Since this study only used one case study (University of Cape Town IS

Honors students), this study's findings must be generalized with caution.

Future studies could use a multiple case study design and include a larger sample size. This study could also be conducted in the future on a longitudinal basis using multiple cases to allow an ongoing evaluation of the performance and success of different teams. Various cases can further the knowledge of both the causality of relationships and the development of teamwork and project success perceptions over time. Another recommendation for further research could include both effectiveness and learning in the conceptual model to further explore project success. Finally, further knowledge can also be obtained by including an interpretive approach to gain more in-depth insight into this case.

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