

Improving Teamwork Quality to Succeed Software Development Project Using AHP (Case Study)

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Abstract

Abstract— IT project management is a combination of traditional project management concepts with a working cycle of information technology systems. The success of an IT project requires strong cooperation and communication between members of the project team. Variables that can affect teamwork quality (TWQ) should be applied to obtain effective teamwork. The variables are communication, coordination, equal contribution of members, mutual support, effort, and team cohesion. Teamwork quality dimensions will be used as a reference for making questionnaires that will be distributed to respondents. In this study, the questionnaires were distributed to two software development companies. The questionnaires are processed by applying Analytical Hierarchy Process (AHP) method. The finding is mutual support has the biggest Eigen factor that influence Teamwork quality. Mutual support means an ability and willingness of team members to assist each other in carrying out their duties. Having the same goals and good team bonding and relationship.

Keywords

IT project management; teamwork; dimension of teamwork; AHP

1. Introduction

Project is a complex process that always produce something new and not repetitive. Project is limited by the time, budget, resources which also known as triple constraints, and designed to satisfy customer specification/needs (Larson & Gray, 2016). The successful project always represented by the efficiency and effectiveness of the resource used in the project. However, many project especially on IT project overwhelmed by the failure. Most of the IT project are not capable enough to meet the deadline because of doing massive rework (Marr, 2016). Survey from Innatas said that more than half of IT project struggle of succeeding the project (Florentine, 2016). All this failure will lead to loss profit and customer loyalty. Many studies investigate the reason to overcome this situation. Marr stated that poor management is supporting 50% of the failure and only 3% is technical problem. from Innatas said that most IT project has a problem to resource allocation and aligning to the business objective (Florentine,

2016). Those facts less mentioned the technical issue that always suspected as the primary problem caused the failure.

Belassi & Tukel (1996) has classified factors to succeed the IT project such as: project manager, project team, project itself, organization, and external environment. In facts those factor will not work well except the strong teamwork and communication among project team members are embedded to every project O'Connor & Yang (2004). Conflict within the team also arise when developing software adapting agile [6]. Although conflict is inevitable but soon or later it will hamper the project success. Many researchers examine about teamwork and communication as the antecedents of project success. Study form Xu & He (2008) the team attitude and its behavior will lead on IT project success. Team 'commitment to the project and the quality of the teamwork are very important and had strong positive attitude to the IT project success. Nevertheless, the exploration of aspect that could improve the teamwork quality were not describe enough from previous research. Thus, this study aimed to explore more factor that could probably increase the teamwork quality toward IT project Success.

Teamwork Dewi (2007) is a form of work in groups that must be organized and well managed. The team consists of a group of heterogeneous and expertise people that is coordinated to execute the given task by the manager. According to Smither et al (1996) the effective teamwork has 9 dimensions such as: the dimension includes understanding of the problem, relevance, and commitment to goals, communication on ideas and feelings, participating leadership, flexible in the use of decision making procedures, constructive conflict management, power by expertise, ability, and information, team cohesion, problem-solving strategies, and interpersonal effectiveness. On the other hand, study form Lindsjörn et.al (2016) variables that affect teamwork quality (TWQ) in software development consists of communication, coordination, equal contribution of members, mutual support, effort, and team cohesion. This study is completed form agile environment.

From several study, factor that can affect TWQ communication among members is strongly needed make great teamwork. But what kind of communication itself that support strong relationship among members of the project is very interesting to be elaborated. In this study we proposed a framework of TWQ. Using case study as method, we investigated variables that affect TWQ. Two companies are selected based on their teamwork maturity level. The company focus on developing software project. Those company are given a test developed by Tuckman. A company which has good score of maturity level will be invited to depth interview about how to create good TWQ to succeed IT project. As a consequence, the company which has lower score of maturity level will get insight or lesson learned for managing the teamwork in their project.

2. Related Work

The development of teamwork was formerly studied by Tuckman (1965). He divided the teamwork into 5 stages as follows:

1. **Forming**
This is the first stage which the members agree to join a team. As new groups are formed, each person brings his own values, opinions and ways of working. Conflict is very rare, everyone is still shy, hesitate to express their opinion, and mostly they feel nervous. Group tends not capable to choose their leader unless the position is assigned first.
2. **Storming**
The stages in which personal conflict begins to arise within the team. Sometime the selected leader is often being questioned about their ability to lead. Team members do not hesitate to replace leaders who are deemed incapable. Communication is blocked since everyone does not want to be a listener.
3. **Norming**
At this stage, the teams are now feel enjoy to work and deal or accept all the conflict arise. Everyone do not hesitate to share the ideas. They trust each other and they also fell that being cooperative teamwork will help to reach the objective.
4. **Performing**
This is the stage where the team has successfully built a system that enables it to work productively and efficiently. At this stage the team's success will be seen from the achievements shown. Group members are interdependent and respect each other while communicating.
5. **Adjourning**
At this stage the teams are dissolved and go to the former position if they are in matrix project.

From whole stages, performing is preferably the best stages when execute the task in the project Nevertheless, the less effective stage goes to storming stage. Though conflict can't be avoided, storming stage is very normal to the teamwork environment. However, it must go to the next stage to reach the objective. Teamwork maturity level is now calculated based on this stages. Variable that relates to the stages (dimension) was investigated by Clark (2016) He divided every stages into 8 variables. He suggested that everyone can know which stages they are by using this maturity test.

Factor that influence TWQ in agile environment has been suggested by Lindsjörn et.al (2016) in which is the development teamwork model by Smither et.al. The factors are communication, coordination, equal work contribution, mutual support, effort and team cohesion. TWQ has positively influence the project success. Hoegel & Gemuenden (2001). However, this study neglects the role of project manager. PMI (2013) O'Connor & Yang (2004) suggested that PM should involve in managing the conflict. Also Tabassi et.al (2011) suggest that TWQ should be retained by giving training related to the improving TWQ. These additional factor will be included to this study to know further which factor that influence the most to the project success.

Table I Teamwork Variables

Variabel	Definition	References
Communication	Communication frequency, openness information sharing	Smither et al (1996), Lindsjörn et.al (2016) Hoegel & Gemuenden (2011)
Coordination	General understanding when working on parallel tasks, and general agreement on structured work, schedule, budget, and deliverables.	Smither et al (1996),Lindsjörn et.al (2016) Hoegel & Gemuenden, (2011)
Leadership	Project manager who can motivate the team, communicate, Facilitate the issue, solve the problem, adopt participate leadership.	Smither et al (1996) Thamhain & Nurick (1999), O'Connor & Yang (2004)
Mutual Support	The ability and willingness of team members to assist each other in carrying out their duties.	Smither et al (1996) Lindsjörn et al (2016); Hoegel & Gemuenden, (2011)
Effort	The ability and willingness of team members to share the workload and prioritize the team's tasks	Smither et al (1996) Lindsjörn et al (2016); Hoegel & Gemuenden, (2011)
Team cohesion	Motivating team members to retain teams and make team goals more important than individual goals	Smither et al (1996) Lindsjörn et al. (2016); Hoegel & Gemuenden, (2011)
Equal team contribution	Ability to fully optimize team members' skills. The team contribution matches with the knowledge and experience of the team members	Smither et al (1996) Lindsjörn et al (2016); Hoegel & Gemuenden, (2011)
External	External factor that affect the team's performance from work environment around the company, and another stakeholders	Tabassi et.al [15], Thamhain & Nurick, (1999)

2. Methodology

Research methodology procedure that has been used in this study comprise 4 steps such as recognize the problem, study the literature for developing dimensions or variable, prepare for the questionnaire, distributed the questionnaire to respondent, conduct TWQ maturity test and apply AHP for investigating the factors.

1. Recognize the problem

At this stage the problem occurs when rate of the project failure tends to increase. Though several studies say teamwork play important role to the project, but the fact practitioners struggle form managing the TWQ. Conflict also may arise in team which inhibits TWQ especially when adopting agile method. Thus investigating factor that may influence toward team success and project success are being explored at this study.

2. Literature review

At this stage, journal, book related to IT project management and Agile method were collected and synthesized. This activity aims to strengthen the research question and also support the analysis of the findings.

3. Create Questionnaire

There are 2 questionnaires used in this research. The first questionnaire is a questionnaire to examine the team work maturity level on the project team. All statement in the questionnaire belong to Clark (2016) which consist of 32 statements. All the statements are also grouped by project life cycle. The second questionnaire is a questionnaire that used to explore factor that impact for TWQ. There are 9 dimension which come from related journal by Lindsjörn et,al (1996). and another studies that related to the topic. The second questionnaire will be proceeded to Analytical Hierarchy Process (AHP) (Saaty, 1993) in order to know the weight in every TWQ factor that has impact toward Project Success.

4. Distribute questionnaire and Result discussion

This stage is carried out the distribution of questionnaires that have been designed. This questionnaire will be given to each expert in the two companies that become the object of research. The company itself focus on developing software and also adopt Agile in their works.

5. Asses teamwork maturity level

Teamwork maturity test form Tuckman has been chosen as an instrument to investigate the maturity level of the selected company. The TW maturity test comprise 32 statements which divided into 4 phase (forming, storming, norming and performing) (Tuckman, 1965; Clark, 2016). Every phase has 8 statements to examine the level. The key person who invited to the test is the project manager. Using 6 scale Likert then the highest score in a certain phase will indicate the stage of maturity they are in.

6. Weighting TWQ dimension

Before processing to AHP method, all variables are being weighted using Likert scale. This weight scoring will be guidance to next stage about calculating or ranking variables.

7. Process the data using AHP

The procedures that used in AHP developed by Saaty (1993) method are:

1. Define the problem and predict desired solution
2. Create hierarchical structure from managerial point of view.
3. Create paired matrix for relative contribution or effect in each elements towards shortest elements above based on decision maker's judgement. In another word, how important these criteria to decision maker's judgement
4. Conduct paired comparison matrices respect to decision maker's goal so it can produce $n \times (n-1)/2$ elements of judgement. N indicates the number of elements that compare to the intensity of importance.
5. Calculate Eigen value and conduct consistency test by placing number "1" at first diagonal in the matrix. It is possible to re-collect data if the consistency test is not working.
6. Repeat step 3,4, and 5 for all hierarchy
7. Calculate Eigen vector (weight from all elements) in every paired comparison matrix to rank the factor ascendingly
8. Check the consistency of the hierarchy. If the value is more than 10%, then the assessment of consideration data should be repeated.

3. Result

A. Teamwork Maturity Level

Based on data form questionnaire, Company Y has the highest score in the norming and performing phase of 39 points, followed by the forming phase of 32 points and the last storming phase of 26 points. From the results the Company Y is achieving great effectiveness of work and minimum conflict. because based on the model designed by Tuckman (1965) Conflict often occurs when a team is in the storming phase, and it can be seen from Table 2 company Y has the smallest score among other phase.

Table 2 Teamwork Maturity Score Company Y

Maturity Level	Score
Forming	32
Storming	26
Norming	39
Performing	39

In another words, company Y has passed the storming phase, the team works very effectively, and the whole team believes what other team members do, so by this time the teamwork form company Y has a great project understanding. Result from the interview that most of the programmer who works at company Y has been working more than 5 years in the same team then the mutual understanding has been created.

However, based on the result from teamwork maturity test, company X get smaller score form company Y in several phases. Company X has the highest points in the performing phase of 38 points, followed by the norming phase of 33 points, then the storming phase of 30 points, and the last forming phase of 28 points. From the results it can be reviewed that Company X is also currently reaching an effective level of teamwork. Compared to company Y, X is slightly struggling form the conflict as seen in the larger storming value.

Table 3 Teamwork Maturity Score Company X

Maturity Level	Score
Forming	28
Storming	30
Norming	33
Performing	38

To interpret what kind of phase they are in, we have to look further which phase has the biggest score at the maturity test. Since both of them has the greatest score in the performing phase it implies that the two company are now facing the same boat. They are in performing phase which indicates good teamwork level. Performing phase means that all the team is working very effective, has the same vision to support project success.

The next step is gathering information from them about managing the teamwork. The proposed framework is being examined by using AHP method from Saaty (1993) AHP is used as a tool to formulate the factor that mostly influence the teamwork quality for successful project.

B. Quality Teamwork

Both company give weighting score to all factors that influence the quality of teamwork before conducting AHP. The result show company Y gives the highest weighted score to that mutual support variables or mutual help variables with weight of 5.43 followed by effort, team cohesion, the external factor variable, equal team contribution, coordination and communication. The Results of weighting score form Company Y tends to give equal score to all factors around 4 to above score. In another hand, company X gives more various score to all statements. Company X scores, communication, coordination, mutual support equal team contribution and external as top 5 factors that affect TWQ. All variables weigh over 4.5 out of a maximum of 6. It implies that they are agree all the factors are very important to enhance TWQ.

Table 4 Weighting Score form AHP (company Y)

No.	Variabel	Company Y		Company X	
		Weight	Rank	Weight	Rank
1	Communication	4,78	5	5,00	1
2	Coordination	5,00	4	4,25	4
3	Leadership	4,67	6	5,00	1
4	Mutual Support	5,43	1	4,71	2
5	Effort	5,25	2	4,25	4
6	Team cohesion	5,10	3	4,20	7
7	Equal team contribution	5,00	4	4,33	3
8	External	5,00	4	4,00	5

Next stage is conversion Likert-scale by using polarization calculation between variable weights as well as teamwork dimension variable. After conversion process then data can be process to AHP method.

Table 5 Priority Vector

Variabel	Priority Vector
Communication	0.13
Coordination	0.13

Leadership	0.12
Mutual Support	0.16
Effort	0.15
Team cohesion	0.11
Equal team contribution	0.11
external	0.08

Table 5 informs us about priority vector in every variable at teamwork dimension. From normalization process, mutual support produces the highest priority vector as for 0,16. The second one is effort as for 0,15 the third are two variables that have equal priority vector such as communication, and coordination. The forth rank is leadership and the last variable which has the smallest Eigen factor of all are team cohesion and equal team contribution.

Table 6 shows the priority vector for both companies. The best communication dimension goes to Company X, since it has 0,67 priority factor compare to Company Y which has 0,33 point. The best coordination dimension goes to Company Y. In another hand, from Company X point of view, the highest priority vector goes to communication, leadership with the same priority vector value of 0.67. While company Y point of view, the highest priority vector goes to effort and external factor with priority vector value of 0.75. However, from whole factor, company Y has selected as the best TWQ since it has the biggest priority vector.

Table 7 Priority Vector form 2 Companies

Variabel	Eigen	Company	Company
Teamwork	Vektor	X	Y
Communication	0.13	0.67	0.33
Coordination	0.13	0.33	0.67
Leadership	0.12	0.67	0.33
Mutual Support	0.16	0.33	0.67
Effort	0.15	0.25	0.75
Team cohesion	0.11	0.25	0.75
Equal team contribution	0.11	0.33	0.67
external	0.08	0.25	0.75
Total		0,39	0,61

4. Discussion

After teamwork maturity level was being conducted then both companies were given a questionnaire about teamwork quality dimension. From AHP process, the best TWQ is software development project is Company Y. company Y has 0,61 point which is greater than company X's score. Afterward, the TWQ dimension form company Y is being investigated. Deep interview is also used to explain further about the TWQ dimension and best practices that has been implemented in both companies. The TWQ dimension was investigated by studying journal related to TWQ in agile environment. AHP was chosen to prioritize which dimension that has greater influence to TWQ in software development. Selected dimension will be discussed as the findings in this research. The neglected dimension is not being elaborated since the Eigen factor has small value. However, it doesn't mean small Eigen factor is useless, somehow we need to boost on or focus on the primary factor which has the greatest impact to successful project.

1. Mutual Support

Mutual support has the largest Eigen factor and potentially support the best factor among all variables that support TWQ in a project. Mutual support means the ability and willingness of team members to assist each other in carrying out their task in the project [10]. Based on interview held on both companies, the mutual support may happen if every member in the team communicate and help each other in doing task. PM should be very open to accept feedback coming from the team. If someone give excellent suggestion about the project, then PM should give appreciation. Appreciation doesn't mean only financial incentive, acknowledge of achievement, giving applause in

the meeting could also increase the spirit and motivation. Any suggestion and feedback can be accommodated first and somehow will be great ideas to the project. If the problem exists, every team in Company Y voluntarily give their hand on project although they are not assigned to the project itself. "Pair Programming", a process in Company Y, is known as doing one activity by two people in order to increase the possibility of sharing knowledge. They believe two head will give better quality output.

2. Effort

Effort has the second largest Eigen factor which contributes TWQ. An effective teamwork usually has the same goals. The only objective of team is how to produce the satisfying deliverable product that matches the project owner expectation. If everyone in a team has this objective they will prioritize this project task. All team members must have the same business or equal task contribution because it will minimize the conflict. According to Lindsjörn et.al (2016) effort means The ability and willingness of team members to share the workload and prioritize the team's tasks. This action will now work unless every member in a team has built good trust each other. Using the same teamwork will create a good team bonding or relationship. In fact, both companies have been using the same teamwork for 5 years

3. Communication

Communication is an important variable in the teamwork dimension, because 90% of project is communicating (2015). From company Y, to create effective communication they give best practice as follow:

1. Send the message clearly while keep monitoring eye contact and gesture.
2. Use face to face meeting to solve the group problem
3. Very open to any feedback (not being defensive), Using communication in achieving specific goals (written / presentations / negotiations),
4. be a good listener when listening and do not try to interrupt, interfere, judge, argue, use cliché phrases.
5. interested in responding the message,
6. changing topics / subjects straight into new directions giving advice.

4. Coordination

Coordination means a common understanding when work on parallel tasks, and general agreement on structural work, schedule, budget, and deliverables. To create great coordination among team, there are several mechanisms such as arranging group discussion by following these rules:

1. Meeting can be formal and informal discussion. Formal discussion need announcement first and supposed to broadcast the objective of the meeting beforehand. Informal discussion somehow works to create strong team bonding. However, don't forget to bring the project status issues both formal and informal meeting.
2. Company used to post meeting announcement on whiteboard. This conventional media is sometimes useful to broadcast sudden meeting before the members arrive to the office.
3. Limit the meeting time will create more conducive conditions and focus on the issues discussed. Somehow the meeting is out of the topic but PM must aware and quickly return to the main issue. Longer time won't be effective then PM should split the meeting in different time
4. Everyone in the meeting has their own voice and should be facilitated to hear out. This practice will help the members stick on the rule and main topic. PM should be notice the member who dominates the meeting because it can make uninteresting and boring meeting atmosphere.
5. Set the meeting rule such as the one who record the minute of meeting, the duration of meeting, media used in the meeting (PowerPoint/whiteboard) milestone of the meeting, Q&A session and so on.
6. Sometime we have to speak up if something irregular happened in the project. As a PM, we have to be calm and not give harsh warning to them. One by one interaction meeting would be best way to handle this situation. That would be better if the objective of the meeting is already known by members whether the meeting is for making decision, solving the issue or problems in a positive way

Both of company are software developer who adopt Scrum as Framework and Agile as methodology. This framework will help the PM arrange the agenda of the meeting in every phase of Scrum. Meetings are scheduled according to the agreed "sprint" duration. "Sprint" is known as unit time in the Scrum. This is also similar to phase or cycle in the project for example one "sprint" equals to 2 weeks, as a consequence there would be several meetings held every week. The meeting is informal situation but does not remove the urgency of meeting objective. The following stages of meeting conducted by both companies are:

- a) Scope meeting, every activity/task that should be done in one sprint is already known by the member then proceed to the scope meeting held at the beginning of the sprint. This meeting aims to know the scope of work in the project. Owner of the project explain to Project Manager about the specification / requirements of the work or high-level information about the project such as product scope, project scope, milestone, duration, risk, stakeholders, budget and many more.
- b) Stand up meeting/daily scrum is held every day and aim to report daily progress of the project. Each developer must report to the Project Manager what they have done and what is upcoming task to accomplish the project. If something problem happened, then session for solving the problem is directly done in this meeting. This meeting used whiteboard and “post-it” to aid reporting information of the project. All the members include the PM prefer stand-up meeting rather than sit-down meeting.
- c) Retrospective is held at the end of the sprint and aims to evaluate the implementation of the sprint. This stage is very useful for acknowledge any changes happened in the project. Every changes are being investigated what are the impact of the changes toward triple constraints.

3. Leadership

Project manager plays important role in the TWQ. Every cycle in the project can't be separated to his/her roles. Many studies reveal style of the leadership of PM support the critical success factor. According to company X and Y the leadership style now shifts to supporting leadership. PM is more flexible when interacts to the team and other stakeholder. PM can adapt easily the style of his/her communication style.

The project manager / product owner must have the ability to motivate team members. According to Butkus & Green (1999), "motivate", means to move, encourage or influence to fulfil the needs. Many theories about encouraging motivation to create higher productivity. At the end, PM who can identify earlier and know the character of their team assign them to the right role will give best result and productivity of the project. PM who can give empathy to their team while communicating can distinguish the average PM and the best PM. Schwalbe (2013) report that PM has responsibility to solve every problem and engage themselves to conflict although conflict in inevitable to the project. Many conflict rise when using Agile then PM plays vital role to solve the conflict. Company Y suggest that PM can use informal communication to the team.

5. Conclusion

Company X and Y is a software developer who use Agile as a method. Several studies confirm that team may arise when adopting Agile. Many researchers suggest framework, critical success factor to create better TWQ in project especially in software development project. However, study who use deep interview to the object and examine the maturity TWQ level is interesting to investigate further and possible to fill the research gap. From the maturity test, both the companies belong to norming and performing stages which indicates good teamwork in their project.

Best practice from company Y to strengthen the TWQ such as doing task faster in executing stage but never neglect great planning stage in project lifecycle. Company Y has a culture that everybody in the team has their voice which beneficial to the project. Every team's voice is being listened whenever is relevant to the project, informal meeting always performs to build team bonding and sometime is used to solve the problem in the office. This informal approach works to create closer atmosphere among project team.

Company Y also suggest that target team should identify acceptance project criteria, target milestone, ground rule at the very beginning work. It is also better to create situation that boost confidence level of the team. Room for research open for examine the effect of each dimension toward the project success. More sample would be better as the representative data of Indonesian software developers. Based on the literature study, questionnaire analysis, and interviews form both companies, creating collaborative teamwork will make the team members enjoy their responsibility in the project.

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