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The Effect of DevOps Implementation on Teamwork Quality in Software Development

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Abstract

Background: The Agile method, which is claimed to reduce time needed for software development cycle has been widely used. It addresses communication gaps between customers and developers. Today, the DevOps has been extended as part of the Agile process to address communication gaps between developer's team members. Despite the rising popularity, the effect of DevOps implementation on the teamwork quality in software development is still unknown.
Objective: The objective of this research is to conduct a study on the impact of DevOps on teamwork quality. Two software houses, PT X and PT Y, are chosen as the case studies.
Methods: This research uses quantitative methods to analyse research data using simple linear regression. The questionnaire technique is used to retrieve respondent data using 62 questions, consisting of 20 DevOps questions from 4 indicators and 42 teamwork quality questions from 6 indicators.
Results: The results from various quality tests indicate that all instruments are valid and reliable while hypothesis tests showed that the DevOps implementation variable has an influence on the teamwork quality variable by 75.6%.
Conclusion: It can be concluded that the implementation of the DevOps in software development has a positive correlation with the teamwork quality.

Keywords: Agile Method, DevOps, Software Development, Teamwork Quality

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I. INTRODUCTION

Nowadays, the number of software houses continues to grow. Although there is no definite data, it is predicted that the number has reached more than 500 companies in Indonesia only [1]. It shows that many companies or organisations need more and more information technology support from the software industry in enabling their business activities. Therefore, there is a need for more convenient methods to increase the effectiveness of the software development activities [2]. This is not only to maintain the quality of software products [3] but also to increase the quality of software processes themselves.

Software development methods play an important role in the development cycle. In a conventional development like the Waterfall model, the communication between customers or stakeholders and the software house tends to be poor and it leads to a longer cycle [4]. To solve the problems and to accelerate the development speed, a new method was created, namely Agile which means 'to move fast and easily'. The Agile method enhances the interaction between customers or stakeholders and developers. Some of the approaches that implement the Agile method include Scrum, Extreme Programming (XP), Lean, and Kanban [5]. The agile method encourages a transition from formal communications to frequent communications. In Scrum, for example, the communication gap is mitigated by conducting daily scrum (stand up meeting), sprint planning, sprint review, and sprint retrospective [6].

Although the Agile method can reduce the time of a software development cycle, there is still a gap between team members that must be addressed [7]. The development team focuses mainly on producing new features and ensures

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that customers or stakeholders are able to use the software as soon as possible. On the other hand, the operation team looks an issue entirely from different aspects; whereby they mainly concentrate on maintaining reliable and bug-free software. This sometimes lead to poor teamwork [8]. To solve this problem, DevOps was introduced as an extension of the Agile method. DevOps brings the development team and the operation team together. Automation plays an important role in the DevOps so that the process of code integration, code testing, and deployment in the Agile method can be done automatically [9].

Many organisations or companies appear to be interested in this new approach to manage their development and operations, including Flickr, Netflix, and Etsy [10]. This method resolves a dilemma that many teams face when there are other teams who want to collaborate in the testing and deployment automation but cannot find a way to do so [11]. DevOps is defined as a modern software development method to respond to the dependency between development and operation by bringing modern methods and tools together to produce a unification between developers and operators [12]. The goal of DevOps is to reduce the processing time required by software development and operation without reducing quality [13]. Thus, applying these methods can increase the efficiency and effectiveness of software development [14].

Apart from the methods applied, the success of an organisation is largely dependent on the team collaboration and efficient communication between team members [15]. Therefore, teamwork quality also needs to be considered. Teamwork is defined as the interdependent performance components needed to organise the performance of multiple people effectively [16]. It means that teamwork is not just work done by team members, but a collective process wherein each team member collaborates [17]. Teamwork quality should be considered using several indicators from many viewpoints [18]. Teamwork quality itself is based on an input-process-output model on group behaviour [19].

Previous studies of DevOps have been conducted. Ref [20] presented how DevOps could be adopted by practitioners in the real world. It is discovered that the DevOps adoption entails a relationship between seven categories, namely automation, agility, continuous measurement, collaborative culture, transparency, resilience, and sharing. More detailed DevOps attributes were studied in [21]. There were 18 attributes assessed under four variables such as automation, source control, continuous delivery, and cohesive teams to help practitioners implement DevOps in their enterprises. Furthermore, a systematic mapping study of DevOps and software quality has been performed in [22]. This research investigated how DevOps features, automation, measurement, sharing, and culture impacted the software quality. However, none of these studies focus on the effect of DevOps on teamwork quality.

This research is performed to study the effect of the DevOps practices on the teamwork quality in software development to find out as to whether DevOps really addresses the gaps between developer's team members. This study was conducted in two IT companies doubling up as software houses, located in the city of Jakarta, Indonesia. PT X and PT Y were chosen as the research subjects since they have implemented the DevOps practices in their software development activities.

II. METHODS

It was found in [23] that DevOps had a positive effect on the teamwork quality, agility to adopt new technologies, and responsiveness to business needs. A positive correlation was also found in [24] between DevOps and software quality. Therefore, we the hypothesis is:

H_1 There is a positive effect of the DevOps implementation on the teamwork quality in software development.

The research model is shown in Fig. 1.

In the DevOps implementation, we determine four indicators as defined in [25] namely automation, collaboration culture, measurement, and sharing. DevOps plays an important role in controlling automation from the development stage to production deployment, as well as in saving time. It also prevents defects and creates consistency. Furthermore, it creates good collaboration culture since DevOps prepares the environment for interaction and allows the team to accept changes. As DevOps enables continuous delivery and deployment, a continuous improvement is needed. These things are measured with a set of key performance indicators which should be open, transparent, easily accessible, able to be processed and visualised. By implementing DevOps, each team member can also share knowledge, code, and documentation to collaborate more quickly and easily and to reduce repetitive work.

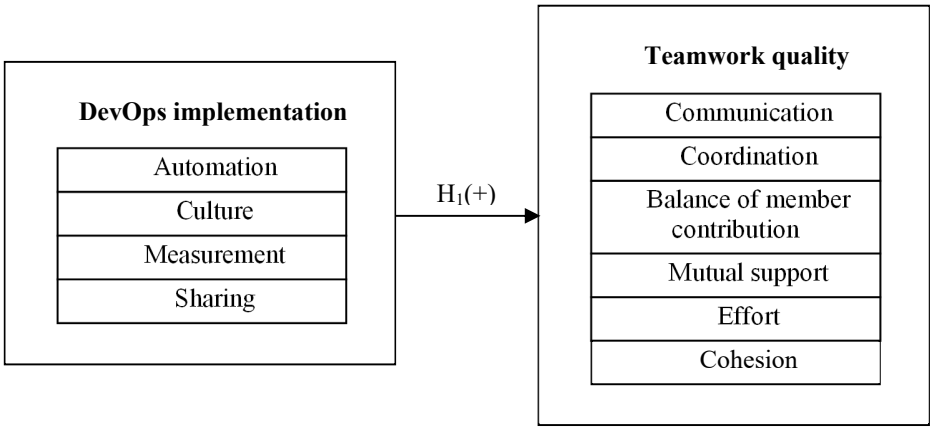

Fig. 1 Research model

In the teamwork quality, we determine six indicators as defined in [19] namely communication, coordination, even contribution among members, mutual support, effort, and cohesion. DevOps underscores the importance of openness and communication in sharing information among members, as well as coordination. Each team member should contribute relevant knowledge and experience to the work whenever relevant. Mutual support is needed and team members should be willing to help each other in carrying out their duties in the project. Moreover, each team member shares the workload and prioritises team tasks over other personal tasks. Thus, uniform effort or shared effort is also one of the main goals in a high-quality collaboration. Meanwhile, cohesion is to what extent an individual wish to stay in the team. If team members do not feel a sense of belonging, or if there is low motivation to keep the team running, then high-quality teamwork is difficult to achieve.

We designed data collection instruments that reflect the indicators as defined above by using questionnaire technique with Likert scale 1 to 5, ranging from (1) disagree, (2) disagree, (3) neutral, (4) agree, (5) strongly agree, to retrieve respondent data using 62 questions, comprising 20 DevOps implementation (PD) questions and 42 teamwork quality (TW) questions. The questionnaires were distributed online to the respondents, who were selected by using the purposive sampling technique, namely the determination of the sample using certain considerations [26]. Quality tests like validity tests, reliability tests, normality tests, and others were performed to check whether the questionnaires are valid or reliable enough. Meanwhile, the hypothesis tests are performed to verify whether the hypothesis is accepted or not.

III. Results

The descriptive statistics of the respondents in terms of genders, ages, and experiences are shown in Fig. 2, Fig. 3, and Fig. 4, respectively.

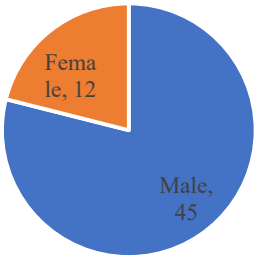

Fig. 2 Respondents' gender

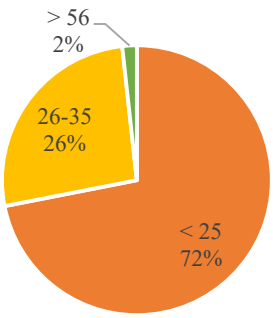

Fig. 3 Respondents' age

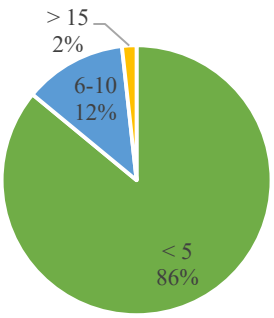

Fig. 4 Respondents' working years

TABLE 1
THE VALIDITY TEST RESULTS FOR THE TEAMWORK QUALITY INSTRUMENTS

Indicators	Question	Description	Pearson Correlation's Value	Explanation
Communication	TW1	There is always communication between team members	0.585	Valid
	TW2	Team members often communicate both directly during meetings and through other communication media	0.523	Valid
	TW3	There is a mediator (someone outside the team) who mediates the communication between team members	0.538	Valid
	TW4	All team members openly share relevant ideas and information about team performance	0.639	Valid
	TW5	In some cases, critical information is kept from other team members	0.388	Valid
	TW6	There is a disagreement within team members about the open flow of information	0.523	Valid
	TW7	Everyone is satisfied with the accuracy of the information from other team members	0.711	Valid
	TW8	Team members love the timeliness where they get information from others	0.721	Valid
	TW9	Everyone is satisfied with the usefulness of the information obtained from other team members	0.638	Valid
Coordination	TW10	The work that is done in the team is very harmonious	0.577	Valid
	TW11	Within the team, there are clear objectives for the subtasks and are fully understood by all members	0.668	Valid
	TW12	There is conflicting interest within team members regarding subtasks	0.488	Valid
	TW13	The division of work at the sub-task level in the team is appropriate with competence, so that it goes well	0.590	Valid
	TW14	There are clear targets to be achieved in the subtasks among team members and all of them understand	0.561	Valid
	TW15	Sub-task targets are approved by all team members	0.685	Valid
Mutual support	TW16	Team members help each other and provide support to one another	0.759	Valid
	TW17	In the event if conflict, settlement is effective and immediate	0.722	Valid
	TW18	Controversies and discussions are handled constructively	0.671	Valid
	TW19	Team members' suggestions, input, and contributions are welcomed and greatly appreciated	0.654	Valid
	TW20	Team members' suggestions, input, and contributions are discussed, developed, and acted upon	0.644	Valid
	TW21	The team members can reach agreement on important matters	0.716	Valid
	TW22	The team members work well together	0.753	Valid
Effort	TW23	Everyone completely encourages teamwork	0.645	Valid
	TW24	Everyone prioritises teamwork above all else	0.774	Valid
	TW25	Everyone strives to achieve the team objectives	0.718	Valid
	TW26	There is a conflict of effort that team members make to achieve performance	0.649	Valid
	TW27	Each team member gives full support to the work given	0.731	Valid
	TW28	Each team member devotes all his abilities to the benefit the team	0.799	Valid
Cohesion	TW29	Each team member feels very attached to this job	0.642	Valid
	TW30	The job is considered very important for team members	0.764	Valid
	TW31	Every team member integrates with and supports each other	0.665	Valid
	TW32	There are good personal relationships among team members	0.700	Valid
	TW33	There are a lot of personal conflicts in the team	0.297	Valid
	TW34	Everyone feels glad to be essential for the team	0.758	Valid
	TW35	Everyone sees nothing extraordinary in teamwork	0.312	Valid
	TW36	Everyone feels safeguarding information in the team are important	0.714	Valid
	TW37	There is a feeling of unity among team members	0.778	Valid
	TW38	There is mutual sympathy among team members	0.759	Valid
Balance of member contribution	TW39	Everyone recognises the special characteristics (qualities and shortcomings) of each team member	0.541	Valid
	TW40	Team members contribute to the accomplishment of team objectives in accordance with their individual abilities	0.525	Valid
	TW41	The imbalance contributions of team members cause conflicts in the team	0.536	Valid
	TW42	There are team members who often underperform their job	0.437	Valid
	TW43	The assignment and division of tasks is in accordance with the abilities of each team member	0.681	Valid
	TW44	Team members' contributions have been shared fairly and equitably	0.699	Valid

TABLE 2
THE VALIDITY TEST RESULTS FOR THE DEVOPS IMPLEMENTATION INSTRUMENTS

Indicators	Question Code	Description	Pearson Correlation's Value	Explanation
Culture	PD1	Team members have sufficient discretion to directly test and deploy their code to the server at any time	0.318	Valid
	PD2	Software is released through small products on a continuous basis	0.487	Valid
	PD3	Products that have been released are monitored to see user feedback	0.752	Valid
	PD4	There is openness, transparency and respect between team members	0.739	Valid
	PD5	Continuous evaluation and improvement are performed	0.741	Valid
Automation	PD6	There is automation between the development process and the development team	0.663	Valid
	PD7	Continuous Integration (CI) and Continuous Delivery (CD) are conducted	0.474	Valid
	PD8	Source codes are stored in the repository	0.494	Valid
	PD9	IT infrastructures are tuned into a set of codes or scripts	0.615	Valid
	PD10	Many automation tools are used	0.611	Valid
Measurement	PD11	In-app on-board guidance service is available	0.353	Valid
	PD12	Software response time can be measured	0.623	Valid
	PD13	To all stakeholders, metrics of measurements are kept transparent and open	0.575	Valid
	PD14	Measurement targets are aligned with common objectives are set	0.676	Valid
	PD15	Unmet measurement targets are followed up and re-established	0.580	Valid
Sharing	PD16	Obstacles are notified without feeling shy and fear	0.665	Valid
	PD17	Problem solving is prioritised rather than blaming	0.687	Valid
	PD18	Workloads are shared with other team members	0.688	Valid
	PD19	Knowledge, information, and documentation are exchanged with others	0.576	Valid
	PD20	There is a good communication with team members	0.756	Valid

The results of validity tests for the instruments of teamwork quality and DevOps implementation are given in Table 1 and Table 2 respectively. A Pearson correlation's value higher than 0.25 indicates that the data collection instrument is valid [27]. Thus, based on the results, all questionnaires are valid. We also performed a reliability test for more quality tests. The reliability test results are given in Table 3. We use Cronbach's alpha as the reliability measure, which is a statistic for internal-consistency reliability. The results show that all values are higher than 0.9, while a Cronbach's alpha higher than 0.5 is considered as an adequate value [27].

Furthermore, the test results can also be strengthened by looking at the normality test using the Kolmogorov-Smirnov [27]. The test result gives a significant value of 0.441. The residual regression model is normally distributed if the data has a significance value of more than 0.05 [27]. Moreover, the heteroscedasticity test is carried out to determine whether there is an inequality of a variant from one residual to another in the regression model. The test result gives a significant value of 0.083. The model is free of heteroscedasticity if the significant value is greater than 0.05 [27].

To determine whether the regression model correlates with the independent variables, the multicollinearity test is conducted. It is carried out by looking at the variance inflation factor (VIF) value and the tolerance value. The VIF is calculated by dividing the variance in a model with numerous terms by the variance of a model with only one term [28]. It evaluates the severity of multicollinearity which provides an index that measures the variance increment of a regression coefficient due to collinearity. Meanwhile, the tolerance is the inverse of the VIF. Multicollinearity happens when at least two indicators are correlated in the model and creates redundant information about the response [29]. The data does not contain multicollinearity if it has a tolerance value of more than 0.1 and a VIF value of less than 10 [27] where the test results yield a value of 1.000 for both indicators. The summary of the test results is given in Table 4.

TABLE 3
THE RESULTS OF THE RELIABILITY TEST

Variable	Cronbach's alpha	Explanation
DevOps implementation (PD)	0.905	> 0.5 = reliable
Teamwork quality (TW)	0.961	> 0.5 = reliable

TABLE 4
THE RESULTS OF THE NORMALITY, THE HETEROSCEDASTICITY, AND THE MULTICOLLINEARITY TESTS

Test	Indicators	Value	Explanation
Normality	Asymp. Sig. (2-tailed)	0.441	Sig. > 0.05 = normal
Heteroscedasticity	Sig.	0.083	Sig. > 0.05 = normal
Multicollinearity	Tolerance	1.000	Tolerance > 0.1 & VIF < 10 = Non-Multicollinearity
	VIF	1.000	

IV. DISCUSSION

We conducted two hypothesis tests, namely the determination coefficient test and the partial test for analysing the acquired data. The coefficient of determination test is carried out to determine the size of the independent variable to explain the dependent variable [28]. The test result gives the R Square value of 0.756. This means that the DevOps implementation variable has an influence on the teamwork quality variable by 75.6%. The remaining 24.4% is influenced by other variables outside this regression equation or variables that are not included in this study. Furthermore, a partial test is performed to find out whether the independent variable can influence the variation of the dependent variable. The results of this test can be obtained from the significant value and the unstandardized coefficients B value [29] where the hypothesis is supported if the significant value is less than 0.05 and the unstandardized coefficients B value is in line with the hypothesis that has been made. Since the results of significant value is 0.000 and the unstandardized coefficients B value is 2.123, which has a positive sign, then the null hypothesis is rejected.

The results show that the implementation of DevOps has a positive effect on teamwork quality in software development. In other words, the more precise the implementation of DevOps on a team, the better the impact it will have on the quality of teamwork in software development. Since the teamwork quality has a very positive effect on team performance [30] [31], then it more likely brings success to the software development project. It not only increases team productivity but also improves coordination and decision making so that it can be positively associated with team effectiveness [32].

The results of this research are supported in [33], which stated that the use of a collaborative system, like DevOps in the context of this study, influences teamwork quality and performance for tasks that are supported by the system. It is also interesting to mention that the project teams which are dominated by younger people could affect the teamwork quality since they are considered as digital native generations and more familiar with technologies [34], such as the collaborative DevOps system, in this context. This result also supports previous studies that claimed there is a positive correlation between DevOps and software quality [22] [24]. Since DevOps has a positive correlation with teamwork quality, then the teamwork quality could also have a positive correlation with software quality. Although, this hypothesis should be studied and tested in the future.

Regarding threats to validity, there could be other variables that are more suitable for this study. Moreover, the hypothesis in this research was also simplified since the study was limited in a such timeframe. As another limitation, the questionnaire was made by the authors only based on the literature in the references. It could be improved if other subject matter experts were involved in creating the questionnaire. Also, it should have been tested and validated before distributing it to the respondents. It is necessary to make sure that all questions in the questionnaire are well-understood by respondents. Furthermore, only two organisations and 57 respondents were selected as the samples, which prevent the generalisations of the results of this study.

V. CONCLUSIONS

A study to determine the effect of the DevOps implementation on teamwork quality has been conducted. This research involved 57 respondents spread across two software houses that have implemented DevOps in their software development activities. Based on the results, it can be concluded that the implementation of DevOps has a positive effect on the teamwork quality in software development. Thus, it is highly recommended for organisations to implement and adapt DevOps in their software development activities so that the teamwork quality can be maximised.

Further research is expected to explore more hypotheses and expand the research objects in order to provide more accurate results. Moreover, other data collection methods other than questionnaires such as direct interviews should be performed in the future to increase the objectivity level of the respondents. Furthermore, it is also expected that future studies are able to increase the size of the respondent samples and obtain more data in order to acquire better results that are closer to general conclusions.

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