How the Team Norm of Information Exchange and Team Information Processing Affects Team Performance in Software Development Projects?

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Abstract

This study examines how the team norm of information exchange and team information processing affects team performance. Data were collected from 354 project teams from software development companies in Thailand. Structural Equation Modelling (SEM) was conducted to test the proposed hypotheses. The results of the study revealed that team norms of information exchange (TNM) has a significant relationship with team information processing (PRO). Team information processing positively influences team performance (TPM). Software development organisations could adopt such norms and this team process to improve software development projects performance and recognise team processes, which is essential for long-term sustainability and competitiveness.

Keywords: team norms of information exchange, team information processing, team performance, software development project

Introduction

Software development is a human-centered process that involves a range of task uncertainty and teamwork challenges (Trendowicz et al., 2008). It involves a high degree of problem solving to arrive at a solution that satisfies the needs of the customer (Eid & Millham, 2013; Ahmed, Capretz, Bouktif, & Campbell, 2012). Team members must deal with the inevitable ambiguity of project goals (Faraj & Sambamurthy, 2006). Moreover, as described by Ebert and Neve (2001), software development requires a high level of teamwork and communication. Numerous software projects fail as systems that are not functioning as planned, not being used, or never completed (Wallace, Keil, & Rai, 2004). Therefore, it is critical to understand what is required to deliver high quality applications on time and within budget (Açıkgoz, Günsel, Bayyurt, & Kuzey, 2014).

The team process is linked to greater team innovation and adaptability, which future organizations expect (Curral, Forrester, Dawson, & West, 2001). Other software development studies highlighted the significance of team processes in software development project performance (Akgün, Lynn, Keskin, & Dogan, 2014; Srivastava, Bartol, & Locke, 2006; Yang & Tang, 2004; Guinan, Cooprider, & Faraj, 1998). Sawyer and Guinan (1998) discovered that team processes result in high-quality software development and are significantly predictive of team performance. Developing and sharing information within teams leads to better performance (Basaglia, Caporarello, Magni, & Pennarola, 2010). However, the link between information processing and software development team performance has been little studied.
Team norms may be significant determinants of team performance (Cohen & Bailey, 1997). When working on a software development project, team norms allow participants to use their information processing skills to produce high-quality software (Açıkgoez et al., 2014; Basaglia et al., 2010). However, teamwork problems can occur in a software development project if they have difficulty implementing the team norm (Maheshwari, Kumar, & Kumar, 2012). Software development is a dynamic process where teams from different experiences come together to create a software application (Sawyer et al., 2010; Guinan et al., 1998). Team norms reinforce devotion to tasks and guide team members' actions (Açıkgoez et al., 2014). However, little research has been undertaken to examine the relationship between team norm of information exchange and team information processing in software development projects.

This study's aim is: (1) to examine the relationship between the team norm of information exchange and team information processing (2) to examine team information processing and team performance.

Theoretical Background and Hypothesis development

The definitions of the variable

The team norm of information exchange refers to the collective willingness of team members to proactively provide each other with helpful information (Deeter-Schmelz & Ramsey, 2003). Team information processing refers to the exchange and analysis of information within the team (Van Offenbeek, 2001). Team performance was assessed for both product and process, with product performance being an indicator of software quality. Software development efficiency is measured by process performance (Liang, Liu, Lin, & Lin, 2007).

Influence of Team norm of information exchange

Lenberg and Feldt (2018) emphasize the great importance of team norms in software development programs and state that the clarity of team norms is a better indicator of team members' performance. According to the normative conduct theory of Cialdini, Kallgren, & Reno, (1991) the effect of team norms of information exchange on team information processing depends on the principle of injunctive norms. When an individual must decide whether to share or discuss information with team members, explicitly establishing team norms allows the individual to spend less time discussing what team activities are appropriate (Wageman, Hackman, & Lehman, 2005). Team norms also allow team members to participate in more interpersonal interactions and share essential information, which leads to new ideas for teamwork (Chatman & Flynn, 2001).

Deeter-Schmelz and Ramsey (2003) found that team norms of information exchange impact team information processing practices. Kim and Shin (2015) also found that cooperative norms encourage team members to be more engaged in sharing information and skills with their teammates, leading to increased team creativity. Based on the previous findings, we proposed that

H1. Team norm of information exchange is positively related to team information processing

Influence of Information processing and Team performance

Information processing in a team will positively influence team performance. According to the research of Faraj and Sproull (2000), coordination and integration of knowledge among team members can improve the performance of software projects. The results and data generated by sharing information within the team would likely take less time for each team member. It is more likely that team members can gain shared knowledge by this process and develop their ability to manage a project, contributing to higher team performance (Chamtitigul and Li, 2021; Chow, 2018).
Leicher and Mulder (2016) have already shown that knowledge sharing shows a significant effect on team performance. Team information processing was found to be a good predictor of team performance in software development projects by Chamtitigul and Li (2021). Thus, we proposed:

H2. Team Information processing is positively related to team performance.

**Methodology**

**Sample and procedure**

The study’s participants are software development project teams from Thai software and IT consulting firms. We collect the list of companies from the database of the Agency for the Promotion of Digital Economy (DEPA) and then contacted HR managers and addressed the objectives of this research. The project selection requirements were told once they confirmed their participation. The first criterion, the team must have consisted of at least two members. The second, the project must only be finished within the last 12 months. HR managers chose the teams and the questionnaires were completed using an online survey program. Additional, one respondent per project was asked to complete the questionnaire based on his or her observations from the behavior of the team members rather than personal preferences. Twenty questionnaires were removed due to the halo effect and 56 questionnaires were removed due to team leader self-assessment. The final sample thus comprised 354 valid responses. Table 1 provides an overview of the sample in terms of demographic and project information.

| Variables          | Categories | Frequency | Percent |
|--------------------|------------|-----------|---------|
| 1. Gender          | Male       | 211       | 59.6%   |
|                    | Female     | 143       | 40.4%   |
| 2. Age             | Less than 30 | 212     | 59.9%   |
|                    | 30-40      | 111       | 31.4%   |
|                    | 41-50      | 24        | 6.8%    |
|                    | ≥51        | 7         | 2%      |
| 3. IT year experience | 0-5 years | 221       | 62.4%   |
|                    | 6-10 years | 81        | 22.9%   |
|                    | 11-15 years | 35      | 9.9%    |
|                    | >15 years  | 17        | 4.8%    |
| 4. Avg. team size  | 2-3 team members | 108     | 30.5%   |
|                    | 4-7 team members | 152    | 42.9%   |
|                    | >7 team members  | 94      | 26.6%   |
| 5. Avg. project duration | <1 year  | 296       | 83.6%   |
|                    | 1-2 years   | 43        | 12.2%   |
|                    | >2 years    | 15        | 4.2%    |

**Measures**

The measurements were established based on previous research. All constructs were evaluated using a five-point Likert scale. Project duration and team size were controlled for the proposed model. Table 2. shows the list of constructs and sources.

| Construct          | Number of questions | Source |
|--------------------|---------------------|--------|

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Results

**Descriptive statistics**

Table 3 shows the construct means, standard deviations, and the intercorrelations between the constructs. Intercorrelations between constructs ranged between -0.210 and 0.561. We found the positive correlation between 1) Team norm of information exchange and information processing, 2) Team norm of information exchange and performance, 3) Team information processing and performance, and 4) team size and project duration.

| Variable                      | Mean | S.D. | Correlations |
|-------------------------------|------|------|--------------|
| 1. Team norm of information exchange | 4.29 | .67  |              |
| 2. Team information processing | 4.09 | .65  | 0.561**      |
| 3. Team performance           | 3.96 | .65  | 0.438**      |
| 4. Team size                  | 6.23 | 4.97 | -0.074       |
| 5. Project duration           | 9.34 | 8.51 | -0.210**     |

**. Correlation is significant at the 0.01 level (2-tailed).

**Confirmatory factor analysis of measurement model**

We conduct confirmatory factor analyses (CFA) to assess the fit between the observed data before testing the hypotheses. Table 4 shows that all Cronbach's alpha values are greater than 0.70, demonstrating high internal consistency for the measurements (Nunnaly, 1978). This study then examined convergent validity. Convergent validity is a term that refers to the extent to which the new scale correlates with other variables and measures of the same construct. All factor loadings were significantly higher than the acceptable standard of 0.5 (p <0.01) proposed by Hair, Black and Babin (1998). All composite reliability scores (CR) exceeded the reliability threshold of 0.7 (Hair, Black, Babin, Anderson, & Tatham, 2006; Fornell & Larcker, 1981). Also, the average variance extracted (AVE) values were more significant than 0.50, indicating acceptability (Hair et al., 2006). Thus, all values of the structures are convergent valid.

| Construct | Factor loading | α    | CR  | AVE  |
|-----------|----------------|------|-----|------|
| ENM       | 0.904          | 0.898| 0.903| 0.756|
| ENM1      | 0.904          | 0.898| 0.903| 0.756|
| ENM2      | 0.891          | 0.891| 0.891| 0.891|
| ENM3      | 0.810          | 0.810| 0.810| 0.810|
| PRO       | 0.882          | 0.882| 0.873| 0.631|
| PRO1      | 0.818          | 0.818| 0.818| 0.818|
| PRO2      | 0.871          | 0.871| 0.871| 0.871|
| PRO3      | 0.771          | 0.771| 0.771| 0.771|
| PRO4      | 0.771          | 0.771| 0.771| 0.771|

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We also examined discriminant validity. The square root of AVE and squared correlation coefficients were presented in the validity. From the results in Table 5, it can be concluded that the square root of AVE for each construct is above 0.5 and greater than the squared correlation coefficients for each construct (Fornell & Larcker, 1981), which confirms discriminant validity.

**Table 5: The construct's discriminant validity**

| Construct | 1        | 2    | 3    | 4    | 5    |
|-----------|---------|------|------|------|------|
| 1. ENM    | 0.869   | -    | -    | -    | -    |
| 2. PRO    | 0.315   | 0.795| -    | -    | -    |
| 3. TPM    | 0.192   | 0.238| 0.747| -    | -    |

*Note: The diagonals describe the square root of the extracted average variance (AVE), and the other items are the squared correlation coefficients ($r^2$)*

**Hypothesis testing**

We run Structural Equation Modelling (SEM) to answer the research questions. Figure 1 shows the results ($\chi^2$=254.334; df=99; $p=0.0$; $\chi^2$/df=2.57; RMSEA=0.067; CFI =0.95; TLI=0.94; SRMR=0.055). As indicated, we found that the TNM-PRO relationship was significant ($\beta = 0.641$, $p < 0.01$), indicating that $H1$ was supported. The PRO - TPM relationship was also significant ($\beta = 0.556$, $p < 0.01$), supporting $H2$. Team size (TMS) and project duration (PRJ) were added when testing the model to address a possible confounding effect. We also found PRJ had a positive effect on TPM.

**Figure 1. Hypothesis proposed model**

**Discussion**

**Theoretical implications**

The aim of this study to examine the influence of team norm information exchange and information processing on team performance. First, we found that team norm of information exchange is positively related to team information processing. Consistent with normative conduct theory (Cialdini et al., 1991), the influence of team norm of information exchange on team information processing is due to
the principle of injunctive norms. Established group norms allow members to collectively process input according to agreed-upon rules. Our results are consistent with previous studies, i.e., team norm has an impact on team processes (Taggar & Ellis, 2007; Shin & Eom, 2014). Second, we also found that team information processing positively predicted team performance. Information processing in a team contributes to the creation of high-quality software applications. Processing information in a team increases productivity because it takes less time and therefore software can be produced faster. Our results are consistent with previous studies, i.e., team process influences team performance (Chamtitigul & Li, 2021; Lee, Gillespie, Mann, & Wearing, 2010; Liu, Keller, & Shih, 2011; Mathieu & Schulze, 2006; Schippers, Homan, & Van Knippenberg, 2003). Appropriate team norms enable team members to move in the same direction and function positively, and promote interactions among team members and team performance (Wang, 2010).

Practical implications

This study provides practical implications for organizations that desire to build teamwork. First, as our results showed, the team norm facilitates the team process that enables the team to develop the task strategically. Therefore, it may be effective for organizations to encourage teams to create a norm of information exchange when the project is in its initial stages. To promote the team norm of information exchange, managers should support and encourage open and transparent communication to continuously maintain effective information sharing and discussions. Maintaining communication behavior in teamwork then becomes a pattern of information exchange behavior and establishes such norm among team members to work together respectfully. Second, we found that team information processing positively predicts team performance. Organizations should recognize the need for team processes (e.g., team information processing) in software development projects. Team information processing promotes social interaction among team members. It also provides an opportunity to share relevant knowledge, which leads to new ideas for higher team performance. Due to the greater complexity of today's businesses and the growing demand for accurate information, managers should emphasise the value of team processes, which are a strategic management tool for long-term success and competitive advantage.

Limitation and future research

This study has limitations that should be taken into account in future studies. First, the results of this study were based on a survey of workers from Thailand. Thus, we are unable to generalize our findings for the workers of other societies. Second, this study was conducted using self-reported information from single respondents. The use of single-response data likely produces the effect of common method bias (CMB), which tend to produce non-causal relationship. Third, this study’s survey was limited to a single industry.

For future research, we suggest to investigate the different types of team processes (e.g., team reflexivity) in the relationship between such norms and team performance. In addition, to confirm our findings, researchers could examine team norms of information exchange and information processing on other types of performance.

Conclusion

This study provides a theoretical evidence-based framework for managing teamwork. The results show that team norms of information exchange significantly influence team information processing. Team information processing positively influences team performance. Our findings will help software development organisations establish team norms and team processes that improve software development project performance.
References

Açıkgöz, A., Günsel, A., Bayyurt, N., & Kuzey, C. (2014). Team climate, team cognition, team intuition, and software quality: The moderating role of project complexity. *Group Decision and Negotiation, 23*(5), 1145-1176.

Ahmed, F., Capretz, L. F., Bouktif, S., & Campbell, P. (2012). Soft skills requirements in software development jobs: A cross-cultural empirical study. *Journal of systems and information technology.*

Akgün, A. E., Lynn, G. S., Keskin, H., & Dogan, D. (2014). Team learning in IT implementation projects: Antecedents and consequences. *International Journal of Information Management, 34*(1), 37-47.

Basaglia, S., Caporarello, L., Magni, M., & Pennarola, F. (2010). IT knowledge integration capability and team performance: the role of team climate. *International Journal of Information Management, 30*(6), 542-551.

Chamtitigul, N., & Li, W. (2021). The influence of demographic heterogeneity on the emergence and consequences of cooperative norms in work teams. *Academy of management journal, 44*(5), 956-974.

Chow, I. H. S. (2018). Cognitive diversity and creativity in teams: the mediating roles of team learning and inclusion. *Chinese Management Studies.*

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. In Advances in experimental social psychology (Vol. 24, pp. 201-234). Academic Press.

Cohen, S. G., & Bailey, D. E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of management, 23*(3), 239-290.

Curral, L. A., Forrester, R. H., Dawson, J. F., & West, M. A. (2001). It's what you do and the way that you do it: Team task, team size, and innovation-related group processes. *European journal of work and organizational psychology, 10*(2), 187-204.

Deeter-Schmelz, D. R., & Ramsey, R. P. (2003). An investigation of team information processing in service teams: Exploring the link between teams and customers. *Journal of the Academy of Marketing Science, 31*(4), 409-424.

Ebert, C., & De Neve, P. (2001). Surviving global software development. *IEEE software, 18*(2), 62-69.

Eid, C., & Millham, R. (2013). Should mathematics be a mandatory fundamental component of any it discipline?. *American Journal of Business Education (AJBE), 6*(1), 67-72.

Faraj, S., & Sambamurthy, V. (2006). Leadership of information systems development projects. *IEEE Transactions on engineering management, 53*(2), 238-249.

Faraj, S., & Sproull, L. (2000). Coordinating expertise in software development teams. *Management science, 46*(12), 1554-1568.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research, 18*(1), 39-50.

Guinan, P. J., Cooprider, J. G., & Faraj, S. (1998). Enabling software development team performance during requirements definition: A behavioral versus technical approach. *Information systems research, 9*(2), 101-125.

Hair, J. F., Black, W. C., & Babin, B. J. (1998). RE Anderson, RL Tatham, and W. C. Black, Multivariate data analysis.(5th ed.). NJ: Prentice—Hall.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). Multivariate data analysis 6th Edition.

Islam, Z., Doshi, J. A., Mahtab, H., & Ahmad, Z. A. (2009). Team learning, top management support and new product development success. *International Journal of Managing Projects in Business.*

Kim, M., & Shin, Y. (2015). Collective efficacy as a mediator between cooperative group norms and group positive affect and team creativity. *Asia Pacific Journal of Management, 32*(3), 693-716.

Lee, P., Gillespie, N., Mann, L., & Wearing, A. (2010). Leadership and trust: Their effect on knowledge sharing and team performance. *Management learning, 41*(4), 473-491.
Leicher, V., & Mulder, R. H. (2016). Team learning, team performance and safe team climate in elder care nursing. *Team Performance Management.*

Lenberg, P., & Feldt, R. (2018, May). Psychological safety and norm clarity in software engineering teams. In Proceedings of the 11th international workshop on cooperative and human aspects of software engineering (pp. 79-86).

Liang, T. P., Liu, C. C., Lin, T. M., & Lin, B. (2007). Effect of team diversity on software project performance. *Industrial Management & Data Systems.*

Liu, Y., Keller, R. T., & Shih, H. A. (2011). The impact of team-member exchange, differentiation, team commitment, and knowledge sharing on R&D project team performance. *R&D Management, 41*(3), 274-287.

Maheshwari, M., Kumar, U., & Kumar, V. (2012). Alignment between social and technical capability in software development teams. *Team Performance Management: An International Journal.*

Mathieu, J. E., & Schulze, W. (2006). The influence of team knowledge and formal plans on episodic team process-performance relationships. *Academy of Management Journal, 49*(3), 605-619.

Nunnaly, J. C. (1978). Psychometric theory. New theory. New York: McGraw-Hill. Paskevich DM, Brawley LR, Dorsch KD, Widmeyer WN (1999). Relationship between collective efficacy and cohesion: Conceptual and measurement issues. *Group Dynamics, 3,* 210-222.

Sawyer, S., & Guinan, P. J. (1998). Software development: Processes and performance. *IBM systems journal, 37*(4), 552-569.

Schippers, M. C., Homan, A. C., & Van Knippenberg, D. (2013). To reflect or not to reflect: Prior team performance as a boundary condition of the effects of reflexivity on learning and final team performance. *Journal of Organizational Behavior, 34*(1), 6-23.

Shin, Y., & Eom, C. (2014). Team proactivity as a linking mechanism between team creative efficacy, transformational leadership, and risk-taking norms and team creative performance. *The Journal of Creative Behavior, 48*(2), 89-114.

Srivastava, A., Bartol, K. M., & Locke, E. A. (2006). Empowering leadership in management teams: Effects on knowledge sharing, efficacy, and performance. *Academy of Management Journal, 49*(6), 1239-1251.

Taggar, S., & Ellis, R. (2007). The role of leaders in shaping formal team norms. *The Leadership Quarterly, 18*(2), 105-120.

Trendowicz, A., Ochs, M., Wickenkamp, A., Münch, J., Ishigai, Y., & Kawaguchi, T. (2008). Integrating Human Judgment and Data Analysis to Identify Factors Influencing Software Development Productivity. *e-Informatica, 2*(1), 47-69.

VAN OFFENBEEK, M. (2001). Processes and outcomes of team learning. *European journal of work and organizational psychology, 10*(3), 303-317.

Wageman, R., Hackman, J. R., & Lehman, E. (2005). Team diagnostic survey: Development of an instrument. *The journal of applied behavioral science, 41*(4), 373-398.

Wallace, L., Keil, M., & Rai, A. (2004). How software project risk affects project performance: An investigation of the dimensions of risk and an exploratory model. *Decision sciences, 35*(2), 289-321.

Wang, M. L. (2010, July). The effect of task characteristics on team norms, cohesion and effectiveness of cross-functional teams in hospitals. In PICMET 2010 technology management for global economic growth (pp. 1-8). IEEE.

Yang, H. L., & Tang, J. H. (2004). Team structure and team performance in IS development: a social network perspective. *Information & management, 41*(3), 335-349.