# Effect of team diversity on software project performance

Ting-Peng Liang and Chih-Chung Liu
*Department of Information Management,
National Sun Yat-sen University, Kaohsiung, Taiwan, Republic of China*
Tse-Min Lin
*Compal Communications, Inc., Taipei, Taiwan, Republic of China, and*
Binshan Lin
*College of Business Administration,
Louisiana State University in Shreveport, Shreveport, Louisiana, USA*

## Abstract

**Purpose** – This research seeks to investigate the relationship between knowledge diversity (KD) in software teams and project performance. Previous research has shown that member diversity affects team performance; most of that work, however, has focused on diversity in personal or social attributes, such as gender or social category. Current research targets at the knowledge level aim to facilitate the implementation of knowledge management in organizations.

**Design/methodology/approach** – A research framework was developed based on conflict theory and empirically tested on software teams in Taiwan.

**Findings** – It was found that KD increases task conflict, which in turn has significant positive effects on team performance and that value diversity (VD) increases relationship conflict, which in turn negatively affects team performance.

**Research limitations/implications** – The findings indicate that task conflict can enhance team performance, while relationship conflict can reduce team performance. Therefore, it is important to maintain healthy relationships among team members.

**Practical implications** – This research concludes that KD is beneficial and that VD is harmful to project outcome in software development. It is, therefore, useful for managers to form teams whose members encompass a broad knowledge base.

**Originality/value** – This paper proposes a novel way to measure knowledge and VD in teams and reports the effects of these attributes on team performance. The work also shows that a proper level of task conflict in a software team is necessary for achieving high performance.

**Keywords** Knowledge management, Value analysis, Conflict, Software engineering

**Paper type** Research paper

## Introduction

The performance of software development teams is an important topic in the information systems (IS) domain. As evident by Moore's law, the information industry has prospered greatly due to rapid price reductions for computer hardware (Kelly, 1998). The enhancement and advancement of function also has played an important role in expediting this progress. However, the success rate of software projects is much

The research was partially supported by research grants to the first author from National Science Council of Taiwan under the contract numbers NSC 92-2416-H110-017, 93-2416-H110-005, and 95-2752-H-110-004-PAE.

Industrial Management & Data Systems
Vol. 107 No. 5, 2007
pp. 636-653

0263-5577
DOI 10.1108/02635570710750408

lower than desired. For example, 18 percent of all projects fail and 53 percent are challenged (Standish Group, 2004). These projects were completed years behind schedule, exceeded their budget by millions of dollars, and failed to meet their users' needs even if completed. Thus, software development is a high-risk enterprise (Karlsen *et al.*, 2006; Faisal *et al.*, 2006). A long-standing key question that has intrigued the minds of researchers concerns the problem in managing software projects efficiently while promoting team performance (Robey and Smith, 1993).

In search of factors for successful team performance, researchers have examined various personality characteristics of team members. As software development is a labor- and knowledge-intensive task, teamwork in software projects has been long acknowledged as a crucial criterion for the successful design and deployment of software projects (Jiang *et al.*, 2003; Gottschalk and Solli-Sather, 2007). Every software project will inevitably face the issue of team composition. It has interested researchers whether bringing diversity in team composition would promote successful teamwork and further lead a project towards fulfillment of its mission, vision, and values. To quantify successful team performance, researchers have studied the personality characteristics, interpersonal relationships and interactions among team members (Barki and Hartwick, 2001; Gottschalk and Karlsen, 2005). Previous research, however, has not shown any major consistent effects of team member diversity on work performance. Byrne's (1971) similarity-attraction theory suggested that similarity in interaction, value, and demographics are favored virtues in team composition as they help maintain effective work environments. In contrast, some diversity theorists and group researchers (Cox *et al.*, 1991; Jehn, 1995; Guzzo and Dickson, 1996) have proclaimed the benefits of diversity in workgroups. Current findings about the effect of diversity on team performance are mixed (Williams and O'Reilly, 1998). Therefore, further research is required to identify the factors underlying the relationship between team diversity and software team performance.

In this study, we derived and tested a new theoretical model to explore what and how diversity affects the performance of software development teams. More specific, we address the following research questions in this paper:

*RQ1*. What kinds of relationships exist between the composition of software teams and performance?

*RQ2*. How does team diversity affect the performance of software development projects?

This research provides a model to explain the effect of diversity on software team performance and an empirical study to test this model. We report two major findings. First, knowledge diversity (KD) significantly increases task conflict, and task conflict positively affects team performance. Project leaders can leverage the knowledge differences of members in order to achieve higher performance. Second, VD increases relationship conflict, which negatively affects performance. Hence, the diversity of values among team members should be minimized. Moreover, interpersonal relationships must be managed carefully in situations where team members have very different values. These findings will help decision makers manage software projects by selecting appropriate team members and effectively managing diversity in workgroups for project success.

The remainder of the paper reviews the literature related to this research and explains the proposed model and methodology, including hypotheses and data collection. We also explain the hypotheses tests and empirical results. Finally, we present the implications of this research as well as some future research directions.

## Theory and hypotheses development

Our model has three main constructs: performance, team diversity, and conflict. To understand the impact of team diversity and conflict on software project performance, these constructs and their interrelationships are discussed below.

### *Team performance*

Performance in software development has several dimensions. This paper concentrates on two of them: production performance and process performance (PP). Gladstein (1984) proposed the concept of "Inputs-Process-Outputs" to explore the key factors for group effectiveness. Henderson (1988) considered team performance by productive efficiency, effectiveness, and timeliness. Efficiency is the ratio of output to input, and effectiveness is the quality of work produced. In the context of project teams, efficiency is a subjective measure of team operations, and the team's adherence to allocated resources. Effectiveness is measured by the quality of work produced and interaction with people outside the team.

However, some researchers argue that it is inadequate to only use productivity to represent performance, especially in knowledge-driven processes (Ruch, 1980). Software development is both labor and knowledge intensive. Moreover, measuring the performance of a software project is complex (Mohrman *et al.*, 1995) and is multi-dimensional and task related (Goodman *et al.*, 1987). Therefore, a popular model for analyzing group performance proposes three phases for measuring team performance: input, group process, and output. The approach uses production efficiency, member's skill improvement, and job satisfaction to measure team performance (Hackman, 1987). There are also studies that focused on cost/schedule control (Abdel-hamid, 1992; Deephouse *et al.*, 1995) or project process (Jiang *et al.*, 2003, Rai and Al-Hindi, 2000) aspect of team performance.

To summary, Nidumolu (1995) argued that performance should be observed in two key aspects, process and product. PP measures how well the software development process was undertaken. Product performance (PO) measures the resulting product actually delivered by the project. We also utilize these two key features of performance for our study.

### *Team diversity*

Team diversity is defined as "any attribute that people use to tell themselves that another person is different" (Jehn, 1999). The definition of demography is traditionally conceptualized in terms of visible differences in age, gender, and race. Individuals may also differ on less visible characteristics such as level of education, tenure with the company or functional background (William and O'Reilly, 1998; Jehn and Katerina, 2004). Decision-making researchers consider diversity as differences in experience and knowledge (Stasser and Titus, 1987). Difference in group composition is an important issue in IS research; some of which has focused on gender, age mix, or personality profiles (Gefen and Straub, 1997; Harrison and Rainer, 1992; Truman and Baroudi, 1994).

Jehn (1999) categorized team diversity into three types, namely, informational diversity, social category diversity (SD), and VD. Informational diversity refers to the variation in knowledge base and perspective that members bring to the software team. Nonaka and Takeuchi (1995) indicated that teams whose members had heterogeneous education backgrounds seemed to have better performance, because the diversity of knowledge would facilitate information exchange and communication from different viewpoints. Tenkasi and Boland (1996) used the term "knowledge diversity" instead of informational diversity. They noted that the domain experts in a knowledge-intensive firm must develop their perspectives, understandings, and knowledge base separately. SD is the explicit difference among team members in social category membership; such as gender, age, and ethic. VD means that members differ in terms of what they think the real task, goal, target, or mission should be.

In sum, three types of diversity, knowledge, social category, and value, were analyze in the study to explore their roles in software team performance.

*Diversity and performance*

Studies of the relationship between diversity and performance so far have yielded mixed findings. For instance, some researchers observed that diverse groups outperformed homogenous groups (Nonaka and Takeuchi, 1995). Other studies, however, demonstrated that homogenous groups could avoid process loss associated with poor communication patterns and excessive conflict that often plagued diverse groups (Guzzo and Dickson, 1996). Furthermore, some research has shown that similarity in tenure could significantly promote social integration and group cohesion. Hence, tenure diversity may have a negative effect on performance (Ancona and Caldwell, 1992). In contrast, other reports indicate that groups with diverse experience and expertise performed better than homogenous groups (Glick *et al.*, 1993). For example, in a laboratory setting, members of mixed gender had lower levels of "friendliness" and higher levels of conflict in comparison with homogeneous gender groups (Alagna *et al.*, 1982). In a field setting, Tsui *et al.* (1992) also reported that being dissimilar in gender resulted in feelings of lower social integration among group members.

A review on 40 years of diversity research by Williams and O'Reilly's (1998) concluded that there were no consistent main effects between diversity and organizational performance. Therefore, instead of arguing that diversity impacts team performance directly, they proposed that certain mediating variables between these two constructs may exist. Some researchers have argued that task conflict (disagreement concerning the subject of a particular task) is the mediating variable that needs to be explored (Pelled, 1996; Jehn, 1999). In this research, we also focus on including "conflict" as the mediator and developing a more elaborate model to explore the relationship among team diversity, conflict, and performance in software development projects.

*Effect of conflict*

People with different backgrounds and belief systems are putting together in a team, chances of disagreement and conflict among them increase. Pondy (1967) categorized conflict into five subcategories: intra-personal, inter-personal, organizational, inter-organizational and revolutionary. This research focuses on the effect of inter-personal conflict. Priem and Kenneth (1991) distinguished between cognitive, task-related conflicts and social-emotional conflicts. Similarly, Pinkley (1990) uncovered a task-versus-relationship dimension of conflict. Jehn (1995) defined task conflict as the disagreement among team members regarding the content of the tasks being performed and differences in viewpoints, ideas, and opinions. He defines relationship conflict as interpersonal incompatibilities among team members, such as tension, animosity, and annoyance among members.

In the present study, we examine the effects of three group composition types – KD, SD, and VD – on two different types of conflict, task conflict and relationship conflict. We then investigate the effects of these two types of conflict on the performance of software development projects.

Differences in educational background, training, and work experience increase the likelihood that diversity in perspectives and opinions exist in workgroups (Stasser, 1992). Prior research has revealed that groups whose members had diverse educational majors experienced more difficulty in defining the direction to proceed than the groups whose members had similar educational backgrounds. Differences in educational background have also caused an increase in the number of conflicts in task-related debates (Jehn, 1999; Kankanhalli *et al.*, 2007). Therefore, we argue that task conflict increases along with KD in software teams and posit the following two hypotheses:

*H1.* Higher levels of KD will lead to higher levels of task conflict.

*H2.* Higher levels of KD will lead to higher levels of relationship conflict.

SD refers to explicit differences among group members in social category membership, such as race, gender, and ethnicity (Pelled, 1996). Explicit social category membership characteristics provide a particularly salient basis by which individuals can categorize themselves and others. Team members could be distinguished by their own social identity. People belonging to the same social category perceive recognition among themselves. When members of different social categories are assigned to the same group, relationship conflicts, such as hostility among members, could arise due to personal preferences or disagreement on non-project related issues (Jehn *et al.*, 1997; Jehn, 1999). Therefore, we argue that SD will positively affect both task conflict and relationship conflict and posit the following two hypotheses:

*H3.* Higher levels of SD will lead to higher levels of task conflict.

*H4.* Higher levels of SD will lead to higher levels of relationship conflict.

Values are a background guide for behavioral choices. VD refers to the situation in which team members perceive different values with respect to certain actions or to the project goal. It may subsequently lead to task conflict. In other words, similarities in values of the group members may reduce possible relationship conflict among members (Jehn, 1994; Pelled, 1996). Therefore, group members who share similar values are more likely to agree on group actions such as goals, tasks, and procedures and hence reduce task conflict. Value similarity can also reduce relationship conflict by increasing the degree to which group members identify with one another (Jehn *et al.*, 1997). Therefore, we posit the following hypotheses:

*H5*. Higher levels of VD will lead to higher levels of task conflict.

*H6*. Higher levels of VD will lead to higher levels of relationship conflict.

Quite a few IS researchers have explored the relationship between conflict and the outcome of software teams (Yeh and Tsai, 2001; Barki and Hartwick, 2001; Sherif *et al.*, 2006), project success (Robey and Smith, 1993), or knowledge sharing within inter-organizational alliances (Pantelia and Sockalingam, 2005). Robey and Smith (1993) examined user participation, conflict, and project success during information system development. Their results showed that some conflict may be beneficial for surfacing and resolving disagreements, but an excessive degree of conflict may overload project members' ability to devise solutions, thus reducing project success. But, it is not clearly understood which type of conflict should be encouraged.

Previous research (Amason and Schweiger, 1994; Jehn, 1994, Jehn, 1995) has also reported that personal attacks and interpersonal disagreements within groups may cause dissatisfaction and hence decrease the amount of individual effort for completing the group task. Personal attacks among group members causes a decrease in concentration, and a waste of effort on quarrelling. Project performance is decreased as a result. When relationship conflict increases, it negatively influences team performance, as team members are not equally contributing to the project. The consequential process loss and withdrawal of group members from cooperative behaviors resulting from relationship conflict decreases opportunities for task coordination and group member synergy, two important features for achieving individually assigned group tasks (Jehn *et al.*, 1997).

On the contrary, Van de Vliert and Euwema (1994) and others (Amason and Schweiger, 1994; Jehn, 1995; Jehn and Chatman, 2000) have observed that task-related conflicts based on disagreements on specific task content are beneficial in many situations. Therefore, we argue that relationship conflict is negatively related to the performance of a software team but task conflict will positively affect the performance. The following two hypotheses are posited:

*H7*. Higher levels of task conflict will lead to higher team performance.

*H8*. Higher levels of relationship conflict will lead to lower team performance.

In summary, we hypothesize that the three types of diversity will have effects on two types of conflict. Further, task conflict will increase team performance, and relationship conflict will decrease team performance. These hypotheses are shown in Figure 1. The symbols *H1-H8* denote the eight hypotheses outlined in this section.

## Variable measurement

According to the research model, there are three groups of constructs for software projects – team diversity, interpersonal conflict, and team performance. They are independent variables, mediating variables, and dependent variables, respectively. Their measurement and indicators are described below.

### *Team diversity*

Team diversity is divided into KD, SD, and VD. KD refers to differences among members on the basis of technical knowledge and perspectives brought to the group.

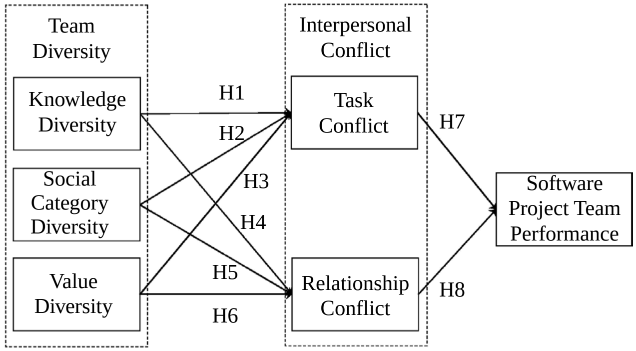


**Figure 1.**
Research model

These differences arise due to differences among team members in education, experience, and expertise.

The concept of KD is similar to informational diversity proposed by Jehn (1999). Informational diversity has been measured by differences in education and functional area in the firm, such as position in the firm, major and level of education, or tenure (Jehn, 1999; Jehn and Katerina, 2004; Pelled *et al.*, 1999). Position in the firm and tenure are related with age. Thus, we adopted three criteria, namely major of study (KD-major), level of education (KD-education), and functional area of work (KD-department), to measure KD. These items are categorical variables. Typically in the treatment of categorical variables, the entropy-based index is used to derive the aggregate measure (Teachman, 1980; Ancona and Caldwell, 1992). The formula of entropy is as below. The index takes into account how team members are distributed among the possible categories of a variable. The total number of categories of a variable is equal to 1, and $P_i$ is the fraction of team members falling into category $i$:

$$\text{Diversity} = -\sum_{i=1}^{n} P_i(\ln P_i)$$

SD is the differences of demographic characteristics, such as ethnicity, nationality, gender, age, and income. Jehn (1999) used gender, age, and ethnic background or nationality of members to measure SD. Because ethnic and culture issues are not considered in the present research, we adopted Jehn's two variables of gender (SD-gender) and age (SD-age). In addition, since income diversity (SD-income) could lead to increased conflict due to members' perceptions on unfair payment, we have included this variable as a measure in our SD. All items for measuring the SD are categorical and, hence, we use the entropy to measure SD.

The measurement of VD was based on the individual value scale developed by O'Reilly *et al.* (1991) which included 35 seven-point Likert-scales questions anchored by 1 = "Strongly disagree" and 7 = "strongly agree". The responses to the VD questions were analyzed using the principal component analysis and were subjected to oblique rotation because of the presumed interrelatedness of the VD constructs. Three extracted factors (VD-fac1, VD-fac2, and VD-fac3) with eigen values greater than 1 were used to calculate the standard deviation of factor score. The calculated result reflects the VD.

*Interpersonal conflict*

Interpersonal conflict is divided into task conflict and relationship conflict. The amount and type of perceived relationship and task conflict are quantified using items of the "intra-group conflict scale" developed by Jehn (1995). Responses to these 12 items were on a five-point Likert scale that rated the occurrence of conflict, anchored by 1 = "None" and 5 = "A lot". Six items in the questionnaire were used to measure relationship conflict. Sample questions for measuring relationship conflict included "How much disagreement exists among members in your project team?" "How much personality conflict is evident in your project team?" and "How much tension exists among members in your project team?" Sample questions for measuring task conflict included: "How frequently do your team members have conflict in idea generation?" and "How often do members in your project team disagree on their opinions?"

*Software project team performance*

Nidumolu's category and variables were used to measure team performance (Nidumolu, 1995). Nidumolu (1995) combined Hackman's process concept and the final production for measuring the performance of software project. PP was measured by three dimensions:

(1) learning from the project (PP-learning) – describes the knowledge acquired by the firm;

(2) process control (PP-control) – describes the extent to which the development process is under control; and

(3) Quality of interactions (PP-interaction) – describes the quality of interactions between IS staff and users during the development process.

PO was also measured by three dimensions:

(1) operational efficiency of the software (PO-efficiency) – describes the technical performance of the software;

(2) responsiveness of software (PO-responsiveness) – describes how well the software responds to the requirements of its users; and

(3) flexibility of software (PO-flexibility) – describes the software's ability to adapt to changing business requirements.

*Research setting and data collection*

The participants of this research were professionals in the information technology industry or MIS managers in Taiwanese firms. To ensure the validity of the collected data, criteria for selecting sample projects included the following:

- The project must have at least five members.
- More than 70 percent of the team members must respond.
- Project manager or team leader must respond.
- The project must be finished within a year.
- Only one or two software teams were included from any given company.

The survey was conducted between June 2005 and July 2005. A total of 185 questionnaires were distributed to members of 30 selected teams. Of these, 102 responses from members in 21 project teams was received. Subsequently, responses were scrutinized based on the above criteria, and 85 responses from 16 project teams were considered valid and used for further analysis. Thus, the response rate was 46 percent (85 responses/185 requests) at the individual level and 53 percent (16/30) at the project team level.

The responsibilities of the participating team members included developing and enhancing software systems in manufacturing, sales, marketing, and administrative divisions. The sample profile was 77.9 percent male, and ages ranged from 20 to 44 years old with a mean age of 30. The majority of respondents (55.8 percent) had IS-related educational backgrounds. The level of education ranged from junior college diploma to master's degrees.

## Data analysis and results

To test the research model, partial least squares (PLS), a latent structural equation modeling technique that utilizes a co-relational principal component-based approach, was used for estimation (Chin, 1997). PLS was chosen for the following reasons:

(1) PLS can assess the measurement model within the context of its theoretical-mediated model and hence is superior to multiple regression and path-analytic techniques.

(2) PLS is well suited for the analysis of a smaller data set in which individual responses are aggregated.

(3) Unlike LISREL, PLS does not make any priori normality assumptions regarding the data (Tiwana and McLean, 2005).

When we limited our model to no more than three paths for any construct, our sample size met Chin's (1997) recommendation that it be five to ten times the largest number of structural paths. The significance of the path coefficients was estimated by bootstrapping with a sample size of 500, as recommended by Chin (1998a, b).

### *Measurement model*

Results from the PLS component-based analysis, correlations among the constructs, $\alpha$ coefficients, reliability tests, PLS-computed variability for each construct, and inter-construct correlations are presented in Tables I and II. Table I provides the correlations of each item to its intended construct (i.e. loadings) and to all other constructs (i.e. cross loadings). Although there are some cross loadings, all items have higher loadings on their own constructs than on other constructs, and all constructs share more variance with their measures than with other constructs. Table II shows that the Cronbach's $\alpha$ coefficients for the items within each construct are sufficiently high (greater than 0.70, as per Nunnally, 1978). Table II also presents the average variance extracted (AVE) as well as the correlations between constructs. Comparing the square root of the AVE (i.e. the diagonals in Table II, representing the average association of each construct to its measures) with the correlations among constructs (i.e. the off-diagonal elements in Table II, representing the overlap association among constructs) indicates that each construct is more closely related to its own measures than to those of other constructs. Therefore, the convergent and discriminant validities of our constructs hold.

| Items | KD | SD | VD | Task conflict | Relationship conflict | Software project team performance |
|---|---|---|---|---|---|---|
| KD-major | 0.9044 | 0.3396 | 0.1883 | 0.6181 | − 0.1512 | 0.4642 |
| KD-education | 0.9415 | 0.5127 | 0.5529 | 0.6613 | 0.3683 | 0.3516 |
| KD-department | 0.7689 | 0.3273 | 0.6985 | 0.4654 | 0.2244 | 0.2792 |
| SD-gender | 0.5178 | 0.6698 | 0.3435 | 0.5270 | 0.4673 | 0.0766 |
| SD-age | 0.3607 | 0.7952 | 0.1428 | 0.5188 | 0.5382 | 0.0013 |
| SD-income | 0.0239 | 0.5918 | 0.2464 | 0.2821 | 0.5068 | 0.3574 |
| VD-fac1 | 0.5894 | 0.0551 | 0.8730 | 0.4757 | − 0.1716 | 0.5178 |
| VD-fac2 | 0.5299 | 0.3673 | 1.0620 | 0.3640 | 0.6011 | − 0.1308 |
| VD-fac3 | 0.5299 | 0.3673 | 1.0620 | 0.3640 | 0.6011 | − 0.1308 |
| Task conflict | 0.7173 | 0.6992 | 0.4073 | 1.0667 | 0.4504 | 0.6357 |
| Relationship conflict | 0.2031 | 0.7752 | 0.5831 | 0.4504 | 1.0667 | − 0.2034 |
| PP-learning | 0.5425 | 0.3737 | − 0.0128 | 0.6779 | − 0.0619 | 0.9593 |
| PP-control | − 0.4146 | − 0.2316 | − 0.4209 | 0.0394 | − 0.2487 | 0.5917 |
| PP-interaction | − 0.3066 | − 0.4981 | − 0.5096 | − 0.2903 | − 0.6890 | 0.5288 |
| PO-efficiency | − 0.4036 | − 0.0661 | − 0.3671 | 0.1558 | 0.0068 | 0.3730 |
| PO-responsiveness | 0.0614 | − 0.2100 | − 0.1650 | 0.0608 | − 0.2599 | 0.6654 |
| PO-flexibility | − 0.6793 | − 0.3269 | − 0.5179 | − 0.4602 | − 0.1555 | 0.3030 |

**Table I.**
PLS component-based analysis: cross-loadings

| Construct | Composite reliability | AVE | KD | SD | VD | Task conflict | Relationship conflict | Software project team performance |
|---|---|---|---|---|---|---|---|---|
| KD | 0.859 | 0.672 | 1.000 | | | | | |
| SD | 0.681 | 0.419 | 0.462 | 1.000 | | | | |
| VD | 0.810 | 0.663 | 0.547 | 0.348 | 1.000 | | | |
| Task conflict | 1.000 | 1.000 | 0.672 | 0.655 | 0.382 | 1.000 | | |
| Relationship conflict | 1.000 | 1.000 | 0.190 | 0.727 | 0.547 | 0.422 | 1.000 | |
| Software project team performance | 0.679 | 0.312 | 0.415 | 0.184 | − 0.077 | 0.596 | − 0.191 | 1.000 |

**Table II.**
Inter-construct correlations: consistency and reliability tests

*Structural model*

Figure 2 is a depiction of the PLS results, and Table III contains the outer-model loadings of the items for each construct. The resulting model accounts for 74 percent of the variance in relationship conflict, 60 percent of the variance in the task conflict, and 59 percent of the variance in team performance. The data in Figure 2 support *H1* and *H3* that KD and SD positively affect task conflict. VD, however, did not significantly affect task conflict, and hence *H5* was not supported. *H7*, that task conflict affects team performance, was supported. The paths that show the positive affect of social category and VD on relationship conflict were also significant. That is, *H4* and *H6* were supported. *H2*, the path between KD and relationship conflict, was not supported. The negative correlation between relationship conflict and team performance was significant, and hence *H8* was supported.

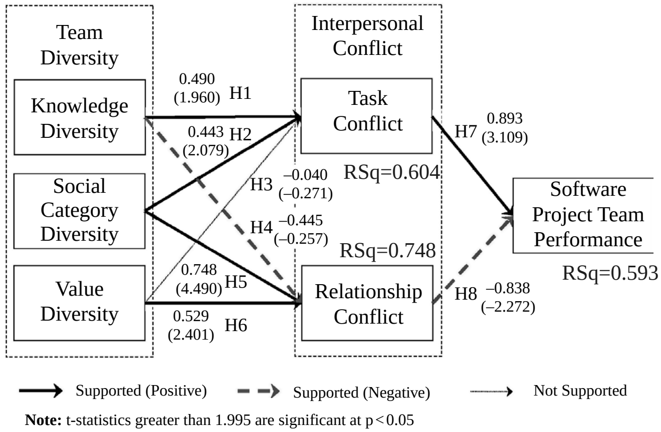


**Figure 2.**
Research results

**Table III.**
Outer model loadings

| Constructs | Variables | Entire sample estimate | Mean of subsamples | Standard error | *t*-statistic |
|---|---|---|---|---|---|
| KD | KD-major | 0.848 | 0.858 | 0.102 | 8.323 |
| | KD-education | 0.883 | 0.827 | 0.128 | 6.884 |
| | KD-department | 0.721 | 0.644 | 0.229 | 3.143 |
| SD | SD-gender | 0.628 | 0.544 | 0.374 | 1.679 |
| | SD-age | 0.746 | 0.612 | 0.345 | 2.163 |
| | SD-income | 0.555 | 0.520 | 0.286 | 1.937 |
| VD | VD-fac1 | 0.082 | −0.336 | 0.431 | 0.190 |
| | VD-fac2 | 0.996 | 0.918 | 0.111 | 8.990 |
| | VD-fac3 | 0.996 | 0.918 | 0.111 | 8.990 |
| Task conflict | | 1.000 | 1.000 | 0.000 | 0.000 |
| Relationship conflict | | 1.000 | 1.000 | 0.000 | 0.000 |
| PP | PP-learning | 0.899 | 0.695 | 0.344 | 2.617 |
| | PP-control | 0.555 | 0.656 | 0.314 | 1.765 |
| | PP-interaction | 0.496 | 0.608 | 0.366 | 1.354 |
| PO | PO-efficiency | 0.350 | 0.410 | 0.376 | 0.930 |
| | PO-responsiveness | 0.624 | 0.611 | 0.268 | 2.325 |
| | PO-flexibility | 0.028 | 0.217 | 0.455 | 0.062 |

## Discussion

The purpose of this study was to explore the differential impact of three team compositional factors (KD, SD, and VD) and two intervening variables (task conflict and relationship conflict) on software team performance. We have developed and empirically assessed our model. Major empirical findings and their possible interpretations are discussed below.

*Finding 1.* KD affects team performance through the effect of both task and relationship conflicts.

As indicated by the significant positive paths from KD to task conflict, and from task conflict to team performance in Figure 2, our results indicate that software teams with higher KD will engender more task conflict and that teams with more task conflict are more likely to produce better team performance. A second path by way of relationship conflict also indicates that an increase in KD will reduce relationship conflicts, which will, in turn, increase team performance. Both paths suggest that managers of a software team may want to assemble a team whose members have diverse knowledge backgrounds to stimulate a higher degree of overall performance. This finding is consistent with the observation of Kankanhalli *et al.* (2007).

*Finding 2.* The relation between SD and performance is mixed.

The effect of SD on team performance is mixed, which is in agreement with the previous study of Jehn (1999). Our findings show that SD positively influences both task conflict and relationship conflict. A possible explanation is that the indicators used to measure social category may have a mixed effect. For example, age as a variable of SD may also correlate with the tenure of members. As shown previously, tenure can lead to task conflict (Jehn, 1995) and relationship conflict (Jehn *et al.*, 1997). Furthermore, Ely (1994) argued that the proportion of males and females is the key effect of gender on performance. These measurement problems may cause the mixed effect we see for SD on team performance.

*Finding 3.* VD negatively affects software team performance.

VD among team members will increase relationship conflict, which negatively affects team performance. Hence, VD negatively affects team performance. This implies that a project manager should carefully choose members with similar value judgment.

*Finding 4.* KD may reduce the relationship conflict among team members.

While most of our hypotheses received support, we did have an unexpected finding. That is, the impact of KD on relationship conflict is negative, a denial of our positive hypothesis. A possible explanation is that team members with heterogeneous educational backgrounds may have better information exchange and communication relationships due to different viewpoints (Nonaka and Takeuchi, 1995), which could facilitate cooperation among team members.

## Managerial implications

This study has several important implications for management. First, the framework we propose can be used by managers to assemble a team for software development. Further, the proposed model also provides a conflict-based mechanism for understanding how diversity affects performance through conflict. Project managers have struggled for ways to enhance IS project performance through conflict management (Barki and Hartwick, 2001). Our study sheds light on this issue.

Second, our empirical results highlight the importance of diversity among team members. This can help management in human resource allocation and team building. Team members may differ in knowledge, social category, and values. These diversities influence the performance of a team. KD, as measured by differences in education and experience, is beneficial to a software team. This may be because that software projects are quite complex and need different skills at different stages of a project (Olla and

Atkinson, 2004). Knowledge difference among members provides more flexibility in matching skills and tasks. Educational diversity may facilitate team members' learning from others, which in turn improves teamwork skills. Members with different professional experience may provide a variety of viewpoints and help improve the quality of decision making. These factors may save mission-critical projects at critical junctures (Liu *et al.*, 2006). Project leaders can gain advantages by leveraging the knowledge differences of members.

Third, our study shows that VD increases relationship conflict. For example, some members are cautious, whereas some are bold. Some members prefer flexible, open-ended standards, while others prefer clear-cut rules. Differences in personal values among team members may reduce team efficiency. Therefore, VD among members should be minimized in software teams. For cases in which team members have very different values, interpersonal relationships must be managed more carefully. Effective management of VD in workgroups is an increasingly critical requirement for project success.

Finally, managers need to deal with conflict among team members during software development. Conflict is an important organizational process, and not all conflicts are harmful to performance. Constructive conflict, referred to commonly in the literature as cognitive conflict, occurs when team members debate differing task-related opinions such as team goals, key decision areas, procedures, and appropriate choices of action (Jehn, 1994; Pelled *et al.*, 1999). Such exchanges help team members better understand issues surrounding the decision context and synthesize multiple perspectives to derive solutions that are superior to those made by any individual team member (Schweiger *et al.*, 1989). For example, Amason (1996) found that cognitive conflict improves decision quality, consensus among team members, and commitment to decisions.

Overall, relationship conflict may lead to negative emotions, such as anger and frustration directed at other team members, and thus it should be minimized for better team cohesiveness. This does not mean that we propose the elimination of drive and passion or the elimination of spirited discussions and debates. Indeed, in some cases these factors are helpful in developing creative and novel solutions to many challenges typically encountered in software projects (Barki and Hartwick, 2001).

## Limitations and future work

The managerial implications laid out above must be considered in light of the study's weaknesses. First, our SD is measured by three factors: age, gender, and income. We have no access to data on ethnic or nationality diversity of the participants. As virtual teams become common practice in software development, cultural differences may be an important issue for software project management. Future research may explore the effect of cultural diversity on a software team.

Second, this research focused on two forms of conflict, task conflict and relationship conflict, as defined by Jehn (1999). Barki and Hartwick (2004) have reviewed different definitions of conflict and summarized them into six major forms of interpersonal conflict. Future research can extend our model to include other forms of conflict.

Third, some of the variable measures were self-reported and thus we cannot rule out the single-response bias in some of our analyses. In the future, a more objective index may be used, such as using the balanced scorecard to measure performance (Huang *et al.*, 2006).

Finally, the sample size in this study was relatively small (16 software project teams). Thus, the data we obtained may be biased when the findings are to be generalized. The validity of our findings is also limited to the power of PLS, the tool we used for data analysis. Future research may consider increasing the sample size to see whether the findings in our study will hold.

## Conclusion

In conclusion, this paper contributes to software team composition by increasing our theoretical and empirical understanding of how team diversity affects its performance. We have presented a framework to exploring the relationship among diversity, conflict, and performance. We differentiated three types of diversity and demonstrated their respective impact on software team performance. The results show that different forms of diversity give rise to different forms of conflict, which in turn affect the perceived team performance. KD positively affects team performance through its impact on task and relationship conflicts. VD may harm team performance through relationship conflict. SD affects both task conflict and relationship conflict, but in opposite directions, to generate a mixed effect on team performance. The results of this study provide direction for creating and managing diverse teams to enhance team performance. Project leaders can enhance team performance by leveraging the knowledge differences of members and by managing inter-group conflicts carefully if the team members have very different values. Our study helps promote effective management of diversity and conflicts in workgroups and delineates the critical importance of these two factors for project success.

## References

Abdel-Hamid, T.K. (1992), "Investigating the impacts of managerial turnover/succession on software project performance", *Journal of Management Information Systems*, Vol. 9 No. 2, pp. 127-44.

Alagna, S., Reddy, D. and Collins, D. (1982), "Perceptions of functioning in mixed-sex and male medical training groups", *Journal of Medical Education*, Vol. 57 No. 10, pp. 801-3.

Amason, A.C. (1996), "Distinguishing the effects of functional and dysfunctional conflict on strategic decision making: resolving a paradox for top management teams", *Academy of Management Journal*, Vol. 39 No. 1, pp. 123-48.

Amason, A.C. and Schweiger, D.M. (1994), "Resolving the paradox of conflict, strategic decision making and organizational performance", *International Journal of Conflict Management*, Vol. 5 No. 3, pp. 239-53.

Ancona, D. and Caldwell, D. (1992), "Demography and design: predictors of new product team performance", *Organization Science*, Vol. 3 No. 3, pp. 321-41.

Barki, H. and Hartwick, J. (2001), "Interpersonal conflict and its management in information system development", *MIS Quarterly*, Vol. 25 No. 2, pp. 195-228.

Barki, H. and Hartwick, J. (2004), "Conceptualizing the construct of interpersonal conflict", *International Journal of Conflict Management*, Vol. 15 No. 3, pp. 216-44.

Byrne, D. (1971), *The Attraction Paradigm*, Academic Press, New York, NY.

Chin, W.W. (1997), "Overview of the PLS method", available at: http://disc-nt.cba.uh.edu/chin/PLSINTRO.HTM

Chin, W.W. (1998a), "Issues and opinion on structural equation modelling", *MIS Quarterly*, Vol. 22 No. 1, pp. vii-xvi.

Chin, W.W. (1998b), "The partial least squares approach for structural equation modelling", in Marcoulides, G.A. (Ed.), *Modern Methods for Business Research*, Lawrence Erlbaum Associates, Mahwah, NJ, pp. 295-336.

Cox, T.H., Lobel, S.A. and McLeod, P. (1991), "Effects of ethnic group cultural differences on cooperative and competitive behavior on a group task", *Academy of Management Journal*, Vol. 34 No. 4, pp. 827-47.

Deephouse, C., Mukhopadhyay, T., Goldenson, D. and Kellner, M. (1995), "Software processes and project performance", *Journal of Management Information Systems*, Vol. 12 No. 3, pp. 187-205.

Ely, R.J. (1994), "Organizational demographics and the dynamics of relationships among professional women", *Administrative Science Quarterly*, Vol. 39 No. 2, pp. 203-38.

Faisal, M.N., Banwet, D.K. and Shankar, R. (2006), "Mapping supply chains on risk and customer sensitivity dimensions", *Industrial Management & Data Systems*, Vol. 106 No. 6, pp. 878-95.

Gefen, D. and Straub, D.W. (1997), "Gender differences in the perception and use of e-mail: an extension to the technology acceptance model", *MIS Quarterly*, Vol. 21 No. 4, pp. 389-400.

Gladstein, D.L. (1984), "Groups in context: a model of task group effectiveness", *Administrative Science Quarterly*, Vol. 29 No. 4, pp. 499-517.

Glick, W., Miller, C. and Huber, W. (1993), "The impact of upper echelon diversity on organizational performance", in Huber, G. and Glick, W. (Eds), *Organizational Change and Redesign*, New York, NY, pp. 176-224.

Goodman, P.S., Ravlin, E. and Schminke, M. (1987), "Understanding groups in organizations", in Cumming, L.L. and Staw, B.M. (Eds), *Research in Organizational Behavior*, JAI Press, Greenwich, CT, pp. 121-73.

Gottschalk, P. and Karlsen, J.T. (2005), "A comparison of leadership roles in internal IT projects versus outsourcing projects", *Industrial Management & Data Systems*, Vol. 105 No. 9, pp. 1137-49.

Gottschalk, P. and Solli-Sather, H. (2007), "Knowledge transfer in IT outsourcing relationships: three international case studies", *International Journal of Innovation and Learning*, Vol. 4 No. 2, pp. 103-11.

Guzzo, R. and Dickson, M.W. (1996), "Team in organizations: recent research on performance and effectiveness", *Annual Reviews Psychology*, Vol. 47 No. 1, pp. 307-38.

Hackman, J.R. (1987), "The design of work team", in Lorsh, J.W. (Ed.), *Handbook of Organizational Behavior*, Prentice-Hall, New York, NY, pp. 315-42.

Harrison, A.W. and Rainer, R.K. Jr (1992), "The influence of individual differences on skill in end-user computing", *Journal of Management Information Systems*, Vol. 9 No. 1, pp. 93-111.

Henderson, J.C. (1988), "Involvement as a predictor of performance in US planning and design", Working Paper No. 175, Center for Information Systems Research, Massachusetts Institute of Technology, Cambridge, MA.

Huang, S.M., Lee, C.L. and Kao, A.C. (2006), "Balancing performance measures for information security management", *Industrial Management & Data Systems*, Vol. 106 No. 2, pp. 242-55.

Jehn, K.A. (1994), "Enhancing effectiveness: an investigation of advantage and disadvantages of value-based intragroup conflict", *International Journal of Conflict Management*, Vol. 5 No. 3, pp. 223-38.

Jehn, K.A. (1995), "A multimethod examination of the benefits and detriments of intragroup conflict", *Administrative Science Quarterly*, Vol. 40 No. 2, pp. 256-83.

Jehn, K.A. (1999), "Why differences make a difference: a field study of diversity, conflict, and performance in workgroups", *Administrative Science Quality*, Vol. 44 No. 4, pp. 741-63.

Jehn, K.A. and Chatman, J.A. (2000), "The influence of proportional and perceptual conflict composition on team performance", *International Journal of Conflict Management*, Vol. 11 No. 1, pp. 56-73.

Jehn, K.A. and Katerina, B. (2004), "A field study of group diversity, workgroup context, and performance", *Journal of Organizational Behavior*, Vol. 25 No. 6, pp. 703-29.

Jehn, K.A., Chadwick, C. and Thatcher, S. (1997), "To agree or not to agree: the effects of value congruence, individual demographic dissimilarity, and conflict on workgroup outcomes", *International Journal of Conflict Management*, Vol. 8 No. 4, pp. 287-306.

Jiang, J.J., Klein, G. and Pick, R.A. (2003), "The impact of IS department organizational environments upon project team performances", *Information & Management*, Vol. 40 No. 3, pp. 213-20.

Kankanhalli, A., Tan, B.C.Y. and Wei, K.K. (2007), "Conflict and performance in global virtual teams", *Journal of Management Information Systems*, Vol. 23 No. 3, pp. 237-74.

Karlsen, J.T., Andersen, J. and Ødegård, E. (2006), "An empirical study of critical success factors in IT projects", *International Journal of Management and Enterprise Development*, Vol. 3 No. 4, pp. 297-311.

Kelly, K. (1998), *New Rules for the New Economy: 10 Radical Strategies for a Connected World*, Viking, New York, NY.

Liu, L.C., Koong, K.S. and Williams, D. (2006), "Some observations on knowledge management software product development", *International Journal of Innovation and Learning*, Vol. 3 No. 1, pp. 1-15.

Mohrman, S.A., Cohen, S.G. and Mohrman, A.M. (1995), *Designing Team-Based Organization: New Forms for Knowledge Work*, Jossey-Bass, San Francisco, CA.

Nidumolu, S.R. (1995), "The effect of coordination and uncertainty on software project performance: residual performance risk as an intervening variable", *Information System Research*, Vol. 6 No. 3, pp. 191-219.

Nonaka, I. and Takeuchi, H. (1995), *The Knowledge-Creating Company*, Rinehart and Winston, New York, NY.

Nunnally, J.C. (1978), *Psychometric Theory*, McGraw-Hill, New York, NY.

Olla, P. and Atkinson, C. (2004), "Developing a wireless reference model for interpreting complexity in wireless projects", *Industrial Management & Data Systems*, Vol. 104 No. 3, pp. 262-72.

O'Reilly, C.A., Chatman, J.A. and Caldwell, D. (1991), "People and organizational culture: a profile comparison approach to assessing person-organization fit", *Academy of Management Journal*, Vol. 34 No. 3, pp. 487-516.

Pantelia, N. and Sockalingam, S. (2005), "Trust and conflict within virtual inter-organizational alliances: a framework for facilitating knowledge sharing", *Decision Support Systems*, Vol. 39 No. 4, pp. 599-617.

Pelled, L. (1996), "Demographic diversity, conflict, and work group outcomes: an intervening process theory", *Organization Science*, Vol. 7 No. 6, pp. 615-31.

Pelled, L.H., Eisenhardt, K.M. and Xin, K.R. (1999), “Exploring the black box: an analysis of work group diversity, conflict, and performance”, *Administrative Science Quarterly*, Vol. 44 No. 1, pp. 1-28.

Pinkley, R.L. (1990), “Dimensions of conflict frame: disputant interpretations of conflict”, *Journal of Applied Psychogy*, Vol. 75 No. 2, pp. 117-26.

Pondy, L.R. (1967), “Organizational conflict: concepts and models”, *Administrative Science Quarterly*, Vol. 12 No. 2, pp. 296-320.

Priem, R. and Kenneth, P. (1991), “Process and outcome expectations for the dialectical inquiry, devil’s advocacy and consensus techniques of strategic decision making”, *Group & Organization Studies*, Vol. 16 No. 2, pp. 206-25.

Rai, A. and Al-Hindi, H. (2000), “The effects of development process modeling and task uncertainty on development quality performance”, *Information & Management*, Vol. 37 No. 6, pp. 335-46.

Robey, D. and Smith, L.A. (1993), “Perceptions of conflict and success in information systems development projects”, *Journal of Management Information Systems*, Vol. 10 No. 1, pp. 123-39.

Ruch, W.A. (1980), “Measuring knowledge worker productivity”, paper presented at conference on productivity research, American Productivity Center, 20-24 April.

Schweiger, D.M., Sanberg, W.R. and Rechner, P.L. (1989), “Experiential effects of dialectical inquiry, devil’s advocacy, and consensus approaches to strategic decision making”, *Academy of Management Journal*, Vol. 32 No. 4, pp. 745-72.

Sherif, K., Zmud, R.W. and Browne, G.J. (2006), “Managing peer-to-peer conflicts in disruptive information technology innovations: the case of software reuse”, *MIS Quarterly*, Vol. 30 No. 2, pp. 339-56.

Standish Group (2004), *Chaos Demographics – 2004 Third Quarter Research Report*, The Standish Group International Inc., West Yarmouth, MA.

Stasser, G. (1992), “Information salience and the discovery of hidden profiles by decision-making groups: ‘a thought experiment’”, *Organizational Behavior and Human Decision Process*, Vol. 52 No. 1, pp. 156-81.

Stasser, G. and Titus, W. (1987), “Effects of information load and percentage of shared information on the dissemination of unshared information during group discussion”, *Journal of Personality and Social Psychology*, Vol. 53 No. 1, pp. 81-93.

Teachman, J.D. (1980), “Analysis of population diversity”, *Sociological Methods of Research*, Vol. 8, pp. 341-62.

Tenkasi, R.V. and Boland, R.J. (1996), “Exploring knowledge diversity as a basis for integration in knowledge intensive firms: a new role for information technology”, *Journal of Organizational Change Management*, Vol. 9 No. 1, pp. 79-91.

Tiwana, A. and McLean, E. (2005), “Expertise integration and creativity in information systems development”, *Journal of Management Information Systems*, Vol. 22 No. 1, pp. 13-43.

Truman, G.E. and Baroudi, J.J. (1994), “Gender differences in the information systems managerial ranks: an assessment of potential discriminatory practices”, *MIS Quarterly*, Vol. 18 No. 2, pp. 129-42.

Tsui, A.S., Egan, T. and O’Reilly, C.A. (1992), “Being different: relational demography and organizational attachment”, *Administrative Science Quarterly*, Vol. 37 No. 4, pp. 549-79.

Van de Vliert, E. and Euwema, M.C. (1994), “Agreeableness and activeness as components of conflict behaviors”, *Journal of Personality and Social Psychology*, Vol. 66 No. 4, pp. 674-87.

Williams, K.Y. and O'Reilly, C.A. (1998), "Demography and diversity in organizations: a review of 40 years of research", *Research in Organizational Behavior*, Vol. 20, pp. 77-140.

Yeh, Q.J. and Tsai, C.L. (2001), "Two conflict potentials during IS development", *Information & Management*, Vol. 39 No. 2, pp. 135-49.

## Further reading

Shapiro, D.L., Furst, S.A., Spreitzer, G.M. and Von G, M. (2002), "Transnational teams in the electronic age: are team identity and high performance at risk?", *Journal of Organizational Behavior*, Vol. 23 No. 4, pp. 455-67.

## Corresponding author

Ting-Peng Liang can be contacted at: tpliang@mail.nsysu.edu.tw