Software Quality as Influenced by Informational Diversity, Task Conflict, and Learning in Project Teams

Ting-Peng Liang, James Jiang, Gary S. Klein, and Julie Yu-Chih Liu

Abstract—**From one perspective, diversity leads to an increase in the knowledge and viewpoints that adds to the creativity of the solution and methods during a software development project. From another perspective, diversity adds to the conflict in a project team, which detracts significantly from the desired results. This contradiction may be best explained by an examination of different forms of diversity. This study reports a model that considers informational diversity, in the form of a larger variety of background knowledge, in the system development context. Learning and information theories dictate that conflict related to the completion of tasks will increase under informational diversity. Task-related conflict should, in turn, create learning opportunities, which will provide the spark needed to improve the quality of the software generated by a project team. A team level analysis of survey data from 299 members of 75 development teams confirms these relationships. The promotion of learning leverages the benefits of informational diversity and serves as a mediator between task-related conflict and software quality.**

Index Terms—**Informational diversity, learning, project management, project teams, relationship conflict, software development, task conflict.**

I. Introduction

Software development (SD) teams have become important vehicles for identifying and designing high-quality solutions to emerging business problems [1]. While adopting a team approach that has become a norm for an SD project, it presents its own intrinsic problems of coordination, motivation, and conflict management [2], [3]. In fact, SD is often treated as a political process involving participation from a diverse membership [4]. In part, the use of teams as organizational units for SD is premised on building teams containing the diversity of information necessary to improve the chances of system success [4], [5]. From this perspective, SD teams should consist of members with diverse education and experience to complement each other by contributing a variety of perspectives and knowledge backgrounds [6].

Information theorists have devoted considerable attention to how teams can generate knowledge and insights beyond the reach of their individual members [7], [8]. Their research suggests that social interaction among diverse perspectives due to diverse backgrounds can lead to the emergence of new insights and effective learning, where learning concerns the processes and technology needed to accomplish the required tasks. In essence, the creation of knowledge and the discovery of insight by teams depend on the presence of diverse viewpoints and perspectives about the task, and lead to improved software quality, where software quality includes how responsive the software is to user needs, how flexible it is in meeting organizational changes, and how efficient it is in operation [9]. However, what makes a group diverse may also prevent the group from realizing the benefits of its diversity. Empirical evidence on the effects of diversity is mixed, especially in the SD literature, with diversity being beneficial in some studies and problematic in others [10]–[12]. Low levels of learning and harmful conflict are uniformly recognized as detrimental effects of diversity [13]. These published results raise a crucial management question: does the practice of building diverse teams cultivate desired outcomes and prevent the detrimental effects of conflict?

II. Research Background

A project team is often defined as a collection of individuals who are *interdependent* in their tasks, who share responsibility for *outcomes*, who see themselves and who are seen by others as *an intact social entity* embedded in one or more larger social systems, and who manage their relationships across organizational boundaries [14]. Project teams produce one-time outputs and possess the characteristics of being knowledge intensive, creating an incremental improvement over an existing concept or a radically new idea, and drawing their members from different disciplines and functional units. Team performance is evaluated in terms of process and product throughout the literature with impacts considered at the individual, team, or organizational level. In this study, we limit teams to SD teams and performance to software quality [15]. Recent work encourages the separation of success along the lines of whether the product, process, or organizational climate is considered, and the quality of software product is considered to be high among the factors targeted by an improved SD process [16]. Such limitation of evaluation is common in creative teams [17].

Team composition is a prime issue as to whether there is value in diversity. Some researchers suggest that diversity can be beneficial for team performance, perhaps by fostering healthy discussion about the best ways to complete project tasks (task conflict) [10]. However, there can be a detrimental

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relationship between diversity and performance, usually through an increase in harmful conflict among team members over personal issues (relationship conflict) [18]. Additionally, diversity comes in a variety of forms, each having its own potential impact [8]. Three categories of diversity include informational diversity (e.g., variations of skills, abilities, and knowledge), social category diversity (e.g., variations in demographics such as age, status, and sex), and value diversity (e.g., variations on attributes such as attitudes, ideals, and principles). Since an SD project is a knowledge-intensive process, this study will focus on informational diversity in the team and conduct the analysis at the team level.

Informational diversity refers to differences in knowledge bases and perspectives that members bring to the group from different educational backgrounds and work experiences [8]. The members of a team bring their differences to the team as a whole and distribute the knowledge to other members as needed to accomplish the project goals [19]. A team with members having knowledge in different domains has a wider knowledge distribution than a team with members with knowledge within the same domain. Empirical evidence demonstrates that a difference in educational background is the most critical factor for measuring a team's informational diversity [8].

III. Research Model and Hypotheses

Information theory argues that diverse groups can have a positive impact on group performance through the increase in the skills, information, and knowledge that diversity brings [20]. Still, few theorists argue for a direct effect in diversity relationships to team success. Many argue that mediators such as conflict and learning might explain diversity effects on success [8], [9], [18]. Different forms of conflict might also have different impacts. For our purposes, we consider task conflicts, those disagreements associated with how to complete the necessary steps in a project, and relational conflicts, those that hinder interpersonal relations [3]. It is generally believed that task-related conflicts will lead to benefits for innovation, complex problems, or product designs, but only in a controlled environment [8]. Yet relationship conflicts will have a negative impact on trust, communications, and coordination among members (interaction quality), and thus, adversely impact final team performance (considered here as software quality).

Our focus narrows the diversity of interest to informational diversity as this is where we propose that potential value arises. Informational diversity should promote learning in the development process by the emergence of new ideas and processes as multiple information perspectives lead to disagreement about task completion [5]. However, informational diversity can also lead to relational conflict, which is detrimental to positive outcomes [8]. Thus, relational conflict is in the model along with its intermediate detrimental effects on interaction quality. To reduce confounds created by personal characteristics, we introduce demographic diversity as a control variable to the conflict types. The complete model is shown in Fig. 1. Variable definitions are summarized in Table I.

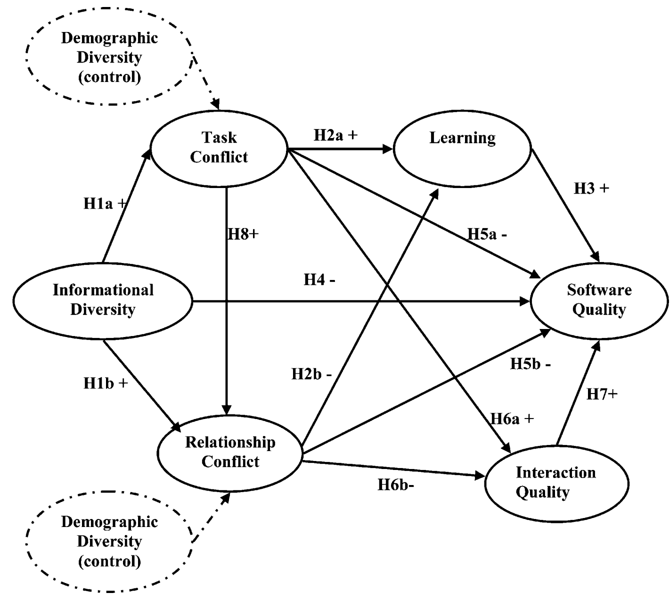

Fig. 1. Research model.

Our primary focus is on the upper linkage in Fig. 1. We seek the value of informational diversity in performance while allowing for the detriments that could potentially outweigh the benefits. Information theory proposes that variance in group composition can have a direct, positive impact by the increase in the skills, abilities, information, and knowledge of diverse membership, independent of what happens in the group process [20]. In the literature, the empirical studies based upon information theory were mainly conducted through laboratory or other controlled settings, such as the classroom, and not supported by studies on organizational work groups [8], [11].

A. Diversity and Conflict

When members of a team have different educational backgrounds and expertise, they likely have dissimilar belief structures [21]. For example, researchers found that executives who have sales and marketing backgrounds typically see opportunities and issues from vantage points that differ from those who have primarily engineering backgrounds [22]. Due to their respective belief structures, members with different expertise and educational backgrounds often possess divergent preferences and interpretations of tasks, which, in turn, are likely to manifest themselves as intragroup conflict. Individuals hold multiple belief structures about a variety of information domains, and those belief structures most relevant to the information-processing task at hand influence interpretation of the task [22].

In other words, as information diversity within a group increases, the task conflict is likely to increase. Members in a more informational diverse team are more likely to hear views that diverge from their own, so task conflict becomes more pronounced. Research in organizational behavior demonstrates that differences in educational background lead to an increase in task-related debates in work teams and relationship conflicts as well [23], [24]. In IS, a related study found that cultural diversity

TABLE I
VARIABLE DEFINITIONS

Terms	Definition
Software Quality	The extent of software responsiveness, operational effectiveness, and flexibility
Informational Diversity	Differences among team members on educational background and work experience that serve to provide a variety of context based knowledge
Demographic Diversity	Differences among team members based on personal characteristics as age, gender and rank
Learning	The extent of knowledge acquired by the team members about the use of key technology, development methods, and user activities
Interaction Quality	The extent of participation and productive communication among team members during the system development process
Task Conflict	The extent of disagreement among team members about task processes and methods
Relationship Conflict	The extent of adverse personal relationships among team members

contributes to both task and relationship conflicts in global, virtual groups [25]. Relationship conflict may arise from the same differences. Thus, for SD teams, we posit the following:

H1a: Informational diversity positively impacts task conflict.
H1b: Informational diversity positively impacts relationship conflict.

B. Conflict and Learning

IS researchers have observed that interactions during system development promote learning [5], [26]. When people are forced to reflect on how they undertake their work in order to explain how to automate it, they have the opportunity to modify their understanding of how their work processes can be improved. These insights, experience, and intuition are exchanged and transferred through person-to-person and intraproject networking. Furthermore, SD project team members often continue to solicit feedback from other team members to refine the system requirements and features until agreement is achieved [4]. This dialogue process extends to the point where the information system (IS) professional is considered to be a knowledge broker in an organization, spreading both technology and functional knowledge across internal boundaries [25].

In general, researchers believe that task conflict can improve learning by incorporating devil's advocacy roles and constructive criticism [27]. Individuals are more likely to learn when the evidence is contradictory to ones' expectations rather than confirming. Research also suggests that task conflicts are constructive, since they stimulate discussion of ideas that help groups perform better [3]. Teams with an absence of task conflict may miss the opportunity of learning new ways of enhancing their productivity. Relationship conflict, however, may impede learning by inhibiting communications [3]. Based on learning theory and the earlier discussion about teams, we posit the following:

H2a: Task conflict positively impacts learning.
H2b: Relationship conflict negatively impacts learning.

C. Learning and Project Performance

When a gap between actual performance and expectancy is realized, organizations will deviate from the previous course of action. The goal of such learning is to improve performance [28]. Whether performance at any level is improved by learning is generally a matter of assumption in knowledge learning research and IS literature [5]. Vandenbosch and Higgins [7] provide evidence that IS success is dependent upon IS members' learning effectiveness; however, they call for future research to examine the direct relationship between learning and product success. Larsen [29] observed that an organization's functional and technological knowledge could both stimulate innovativeness as well as information technology adoption success. Huang and Newell [30] observed that the level of knowledge sharing has a positive impact on project outcomes. Majchrzak *et al.* [4] observed that user learning has a positive impact on IS short-term outcomes. Thus, based on limited empirical results of learning models and the works of organizational learning theorists, we expect to find the following for SD teams:

H3: Team learning positively impacts software quality.

D. Diversity, Conflict, Interactions, and Software Quality

To account for a fuller model, the dark side of diversity and conflict is also considered. As discussed before, some researchers have argued that diversity can be beneficial for groups while others have shown strong evidence that diversity is deleterious to group functioning [31]. As such, diversity appears to be a double-edged sword, increasing the opportunity for creativity as well as the likelihood that group members fail to function effectively. Likewise, the effects of diversity may not be fully mediated by task conflict and learning. In fact, empirical evidence shows that teams with diverse members often prove ineffective in capitalizing on the potential benefits of their informational diversity [32]. Success often hinges on the ability of the team to embrace, experience, and manage disagreements that arise. In other words, the model may not be fully defined since no

TABLE II
CONTINUOUS DEMOGRAPHIC INFORMATION

Variables (yrs)	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	21.00	57.00	31.38	5.20
Respondent's time with organization	0.08	28.00	4.04	3.95
Project duration (years)	0.40	5.00	1.73	1.20
Team size	5.00	10.00	6.37	1.48

mechanisms for harnessing the diversity directly are included. Thus, for SD teams

H4: Informational diversity negatively impacts software quality.

In addition, prior studies indicate that conflict seriously limits team performance and productivity [10], [15], [33]. Irrespective of its source, conflict has the potential to limit performance directly by detracting from achieving the project goals as well as by preventing the interaction quality necessary to produce a better product. To compensate for harmful conflict effects, time and effort must be spent on interpersonal aspects of the group rather than on technical and decision-making tasks [34]. Thus, the following hypotheses are included in the model to account for the detrimental impacts of conflict and the need for productive interactions in the face of conflict:

H5a: Task conflict negatively impacts software quality.
H5b: Relational conflict negatively impacts software quality.
H6a: Task conflict negatively impacts interaction quality.
H6b: Relational conflict negatively impacts interaction quality.
H7: Interaction quality positively impacts software quality.

A final consideration is made to the relationship between conflict types. Should task conflict prove beneficial to success and relationship conflict a hindrance, then the two should be separable. Accordingly, a previous study determined that task conflict contributes to relationship conflict [35]. However, should this link be overcome, then the consequences need not be severe. Accordingly, the link between task conflict and relationship conflict is examined to determine if it holds any significance in the presence of the remainder of the model; in other words, the impact is mitigated. Thus, for SD teams, we test the following:

H8: Task conflict positively impacts relationship conflict.

TABLE III
CATEGORICAL DEMOGRAPHIC INFORMATION

Variables	Categories	#	Percent
Gender	Male	217	72.6
	Female	80	26.8
	Missing Value	2	0.74
Role in the team	Team leader	49	16.4
	Team member	243	81.3
	Missing	7	2.3
Department	Marketing	5	1.7
	R&D	17	5.7
	MIS	180	60.2
	Engineering	27	9.0
	HR	61	20.4
	Others	6	2.1
	Missing	3	1.0
Education Level	Graduate	128	42.8
	College (4 yrs)	146	48.8
	College (2 yrs)	23	7.7
	Other	2	0.6
Current Position	Technical professional	162	54.2
	General staff	87	29.1
	Manager	39	13.0
	Others	4	1.3
	Missing	7	2.3
College Major	MIS	166	55.5
	Other Business	18	6.0
	Science	28	9.4
	Engineering	62	20.7
	Humanities	14	4.7
	Missing	11	3.7

IV. RESEARCH METHODS

A. Sampling

The sample of this study is generated by IS project managers listed in the Project Management Institute's (PMI) member list in Taiwan. These managers were first contacted by phone to determine whether they had completed a project within the most recent 12 months as a project manager and whether the project team consisted of at least five members—up to a maximum of 10 members. The number of team members ranging from 5 to 10 was selected because the literature suggests that the optimal team size is around 5 to 7, and a team above ten members is less effective [36]. A questionnaire package, including cover letters and questionnaires about personal characteristics, project process variables, and software quality, was sent to 56 identified project managers (with a total of 510 members in 112 SD project teams) who agreed to participate. Each project manager was asked to distribute questionnaires to the project team members of each project the manager identified.

Data from both project team managers and team members are needed to gain a snapshot of the diversity in the whole team as well as the process characteristics and software quality. For evaluative purposes, all members of the project team should have familiarity with the process characteristics of a project [9], [15]. Software quality is often measured from a manufacturing view, which is best evaluated throughout the life cycle of development by the developers [37]–[39]. In addition, a number of recent studies have found that development team members are able

TABLE IV
QUESTIONNAIRE ITEMS AND CONSTRUCT COMPOSITION

Construct	Items	Factor loading	t-value*	ICC
Task conflict	Team member often disagree about ways to accomplish goals	0.89	26.48	0.62
	Team members have different goals	0.81	15.70	0.67
	Team members have different ideas about project content	0.88	28.15	0.63
Relationship conflict	There is much friction among members in your team	0.88	31.01	0.79
	There is much personality conflict evident in your team	0.86	24.31	0.80
	There is much tension among members of your team	0.92	53.04	0.86
	There is much emotional conflict among your team	0.88	35.07	0.75
	Team members are envious and contradict each other	0.90	38.13	0.84
	Some team members don't like each other	0.88	32.32	0.75
Learning	Knowledge is acquired by you about use of key technologies	0.91	44.27	0.75
	Knowledge is acquired by you about use of development techniques	0.92	57.49	0.75
	Knowledge is acquired by you about supporting user activities	0.86	23.28	0.70
Interaction Quality	Feeling of participation	0.75	10.32	0.55
	Completeness of training	0.74	12.67	0.58
	Frequency of communications among team members	0.88	36.43	0.67
	Overall team interaction quality	0.90	41.64	0.64
Software Quality	Ability to customize outputs to various user needs	0.70	11.90	0.50
	Range of outputs that can be generated	0.77	12.22	0.51
	Efficient cost of adapting software to changes in business	0.80	14.99	0.66
	Rapid adapting of software to changes in business	0.69	6.19	0.59
	Efficient cost of maintaining software over lifetime	0.77	12.98	0.58
	Reliable software	0.76	10.12	0.65
	Efficient cost of software operations	0.84	21.50	0.65
	Quick response time	0.73	14.29	0.58

*All *t*-values significant at $p < .05$.

to judge project process and software quality items [40]–[43]. All the respondents were assured that their responses would be kept confidential. Respondents were asked to answer questions based on their most recently completed project with the identified project manager. The target returned questionnaires from 80 teams, of which 299 instruments from 75 SD project teams were usable. Only teams with at least a 50% response rate were retained as team variables will require sufficient individual sampling. Tables II and III summarize the demographic information.

B. Constructs

Informational diversity refers to differences in knowledge bases and perspectives that members bring to the IS team. Such differences are likely to arise as a function of differences among group members in education, experience, and expertise. Following past research [23], informational diversity measures should assess heterogeneity of education (i.e., major) and functional areas in the firm (i.e., marketing, operations, information systems). Demographic diversity is based on characteristics of difference measurable by common demographic variables—gender and age. As is typical in the treatment of categorical variables, we used an entropy-based index [44] to provide an aggregate measure of the informational and demographic diversity within the SD team that represents the proportion of the team unit that has each characteristic. If a demographic characteristic is not represented, the value assigned is zero. The diversity index becomes the sum of the products of each characteristic's proportion in the team unit's makeup and the natural log of its proportion. A higher value of the diversity index represents a greater distribution of characteristics within the team. Overall informational diversity is the sum of the position, educational level and major, seniority, and department diversities.

TABLE V
CONVERGENT VALIDITY

Construct	Composite Reliability	Cronbach's α
Task Conflict	0.89	0.80
Relationship Conflict	0.96	0.93
Learning	0.93	0.86
Interaction Quality	0.89	0.80
Software Quality	0.92	0.85

Relationship conflict and task conflict measure an amount of each conflict type, relationship being the adverse personal conflicts in the group, and task conflicts being disagreement about processes and products. The items used in measuring conflicts were developed by Jehn [3] to measure the amount and type of perceived task and relationship conflicts in team units. The nine items in the presence of conflict were rated on a five-point Likert scale anchored by 1 = "not agree at all" and 5 = "totally agree." The measurement items, their factor loadings, and item-construct correlations (ICC) are shown in Table IV.

As *learning* describes the knowledge being acquired by the SD team members, the construct measurement, as shown in

TABLE VI
CONSTRUCT DESCRIPTIVE STATISTICS

	Mean	STD	M3	M4	Correlations						
					DD	ID	TC	RC	L	IQ	SQ
Demographic Diversity (DD)	0.19	0.11	-0.22	-1.45	--						
Information Diversity (ID)	0.39	0.16	0.37	1.35	0.34	--					
Task Conflict (TC)	3.49	0.41	0.44	0.69	0.20	0.21	**0.86**				
Relationship Conflict (RC)	2.70	0.55	0.13	-0.56	0.27	-0.03	0.31	**0.88**			
Learning (L)	3.85	0.34	-0.19	-0.26	-0.08	0.29	0.36	-0.18	**0.90**		
Interaction Quality (IQ)	3.62	0.40	-0.14	-0.45	-0.16	0.08	0.08	-0.42	0.39	**0.82**	
Software Quality (SQ)	3.54	0.36	0.24	0.31	-0.25	-0.03	-0.01	-0.21	0.38	0.38	**0.76**

Notes: The diagonal line of correlation matrix indicates the square root of AVE
M3: Skewness; M4: Kurtosis

TABLE VII
R_{wg} SIMILARITY MEASURES

Team	Task Conflict	Relation Conflict	Learning	Interact Quality	Software Quality	Team	Task Conflict	Relation Conflict	Learning	Interact Quality	Software Quality
1	0.93	0.85	0.73	0.86	0.97	41	0.94	0.86	0.91	0.92	0.89
2	0.38	0.83	0.71	0.95	0.96	42	0.75	0.87	0.94	0.74	0.94
3	0.62	0.89	0.99	0.93	0.95	43	0.76	0.41	0.83	0.79	0.95
4	0.75	0.98	0.94	0.99	0.98	44	0.98	0.87	0.94	0.67	0.99
5	0.94	0.94	0.98	0.97	0.99	45	0.86	0.90	0.76	0.96	0.95
6	3.00	1.48	0.94	0.92	0.91	46	0.77	0.73	0.99	0.95	0.94
7	0.84	0.87	0.93	0.95	0.96	47	0.67	2.13	0.73	0.90	0.96
8	0.69	0.94	0.96	0.92	0.98	48	0.90	0.93	0.95	0.97	0.97
9	0.94	0.82	0.97	0.93	0.92	49	0.96	0.90	0.86	0.98	0.97
10	0.60	0.88	0.94	0.95	0.96	50	0.78	0.56	0.95	0.91	0.97
11	0.95	0.67	0.76	0.86	0.95	51	0.66	0.95	0.46	0.87	0.94
12	0.95	0.82	0.92	0.97	0.96	52	0.90	1.00	0.94	0.57	1.00
13	0.87	0.91	0.94	0.84	0.98	53	0.97	0.75	0.90	0.97	0.96
14	0.87	0.94	0.99	0.97	0.97	54	7.50	0.96	0.90	0.97	0.97
15	0.83	0.79	0.91	0.95	0.97	55	0.81	0.95	0.97	0.97	0.96
16	0.90	0.97	0.93	0.93	0.97	56	0.96	0.97	0.85	0.97	0.94
17	0.77	0.96	0.52	0.96	0.97	57	0.96	0.95	0.89	0.94	0.98
18	0.93	0.84	0.90	0.85	0.97	58	0.50	0.98	0.97	0.97	0.99
19	0.89	0.35	0.94	0.85	0.95	59	0.50	0.99	0.50	0.95	0.90
20	0.96	0.98	0.89	0.95	0.98	60	0.94	0.95	0.96	0.95	0.98
21	0.88	0.95	0.90	0.99	0.99	61	0.86	0.87	0.92	0.90	0.97
22	0.91	0.95	1.00	0.95	1.00	62	0.88	0.69	0.92	0.86	0.97
23	0.74	0.76	0.81	0.92	0.98	63	0.96	0.94	0.93	0.93	0.99
24	0.81	0.85	0.81	0.84	0.96	64	0.94	0.97	0.95	0.98	0.98
25	0.98	0.98	0.94	0.89	0.98	65	0.40	0.95	0.87	0.89	0.96
26	0.91	0.75	1.00	0.95	0.93	66	0.92	0.95	0.96	0.98	0.99
27	0.95	0.97	0.86	0.91	0.98	67	0.96	0.98	0.93	0.99	0.98
28	0.88	0.80	0.92	0.93	0.94	68	0.99	0.97	0.96	0.98	0.97
29	0.71	0.97	0.75	0.94	0.98	69	0.95	0.97	0.99	0.97	0.99
30	0.89	0.95	0.94	0.95	0.96	70	0.97	0.95	0.96	0.90	0.98
31	0.97	0.96	0.90	1.00	0.99	71	0.97	0.98	0.95	0.99	0.98
32	0.91	0.92	0.91	0.88	0.98	72	0.88	0.88	0.92	0.97	0.97
33	0.94	0.95	0.86	0.95	0.97	73	0.97	0.98	0.95	0.98	0.98
34	0.60	0.95	0.89	0.74	0.98	74	0.88	0.94	0.94	0.93	0.98
35	0.90	0.98	0.90	0.95	0.98	75	0.95	0.96	0.95	0.93	0.97
36	0.89	0.87	0.96	0.96	0.96						
37	0.84	0.96	0.99	0.97	0.98						
38	0.87	0.92	0.83	0.95	0.98						
39	0.88	0.84	0.99	0.88	0.95						
40	0.84	0.88	0.95	0.96	0.98						

Table IV, includes three items that were applied in previous studies involving team members' learning [45]. Respondents were asked to indicate the extent of the items typically incurred by them when developing software in their projects. Each item was scored using a five-point scale ranging from never occurring (1) to always occurring (5). All items were presented such that the greater the score, the greater the extent the particular item occurred.

Software quality includes the three software quality dimensions of software responsiveness, software operation effectiveness, and software flexibility measured by items shown in Table IV. *Software responsiveness* refers to how the system meets user needs and is measured by three items. There are three items used in this study for measuring *software operations efficiency*, which considers the production of varied reports in a rapid, cost-effective fashion. *Software flexibility* describes the software's ability to adapt to changing business needs and is measured by the remaining items. *Interaction quality* is among team members during the development process. The quality items used in this study are adapted from Nidumolu [15]. Each item was scored using a five-point Likert-type scale. All items were presented such that the greater the score, the greater the extent the particular item occurred.

C. Data Analysis and Results

Since the research model includes multiple paths, data were analyzed by structural equation modeling (SEM) with partial least squares (PLSs) analysis, which allow empirical assessment of the constructs used in this study [46]. Using ordinary least squares, PLS performs an iterative set of factor analyses and applies a bootstrap approach to estimate the significance (t-values) of the items. In this study, PLS-Graph Version 3.01 [47] was used to verify the measurement and structural models. Individual item reliability is examined by observing the factor loading of each item. A high loading implies that the shared variance between constructs and its measurement is higher than the error variance [48]. In Table IV, the loading of all indicators is above 0.6, which indicates that the measurement is acceptable, and all loadings test significant. Variables are computed using the factor scores instead of simple averages.

Convergent validity should be assured when multiple indicators are used to measure one construct. Convergent validity can be examined by the composite reliability of constructs in Table V (>0.70 is recommended) and item-construct correlation in Table IV (>0.70 is recommended) [49]. Table V also shows the Cronbach alpha values, which exceed the recommended level of 0.70 to indicate acceptable data reliability. Average variance extracted (AVE) reflects the variance captured by the indicators. Evidence regarding discriminant validity is established with the square root of AVE being greater than the correlations of the constructs, supporting the discriminant validity of the scales [49]. These values are presented in Table VI and indicate no problems. Systemic bias, due to the inflation of variables, does not appear to be present since the third and fourth moments are small [50].

The study employs a team level of analysis. To compose group measures, the individuals should show consistency to increase confidence in the combination of individual responses to the group aggregate. Table VII shows the R_{wg} similarity measures for each variable of each group [51]. A value greater than 0.7 for each variable is considered adequate to aggregate the individuals into groups. Only a few exceptions to this exist in the data, and never for more than one variable in each group. Overall, these data show a high degree of similarity and can be aggregated for further analysis [51].

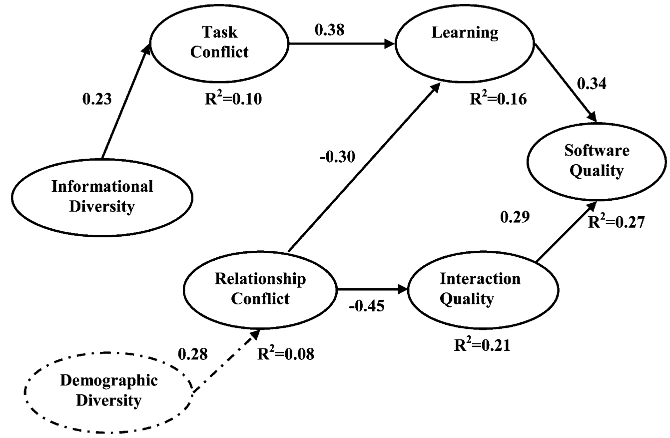

Fig. 2. Resulting structural model.

Since independent and dependent variables are from the same rater, common method variance might jeopardize the analysis result and additional inference [52]. Harman's single factor test was used to test the common method variance. A total of 29 items (four items for learning, interaction quality, responsiveness, flexibility, and operation efficiency; three items for task conflict; and six items for relationship conflict) were entered into an exploratory factor analysis. A total of 7 factors were extracted and the total explained variance is 71%. The variance explained by a one-factor model is 23.82%, indicating no one factor can represent all indicators, and therefore, common method variance is not evident in this study.

The test of the structural model involves estimating the path coefficients, which indicate the strengths of the relationships between the dependent and independent variables. Significant coefficients indicate relationships are present. The R^2 value indicates the amount of variance explained by the independent variables and is more the predictive power of the model. Both values interpret the same as in multiple regression. A bootstrap resampling procedure was used to generate t-statistics and standard errors [53]. The bootstrap procedure utilizes a confidence estimation procedure other than the normal approximation. The bootstrap procedure samples with replacement from the original sample set until it reaches the specified number. In this study, a resample of 250 is chosen.

Fig. 2 shows the significant links found in the data for the research model. Table VIII summarizes the results for the hypotheses. The upper path in Fig. 1 is supported as shown in Fig. 2. The significant impacts are all in the directions expected as determined by the PLS coefficients. This indicates that informational diversity does lead to task conflict (H1a), which promotes learning (H2a), which, in turn, improves the software quality (H3).

TABLE VIII
HYPOTHESES SUMMARY

Hypothesis	**Result (at p < .05)**
H1a: *Informational diversity positively impacts task conflict*	supported
H1b: *Informational diversity positively impacts relationship conflict*	not supported
H2a: *Task conflict positively impacts learning*	supported
H2b: *Relationship conflict negatively impacts learning*	supported
H3: *Team learning positively impacts software quality*	supported
H4: *Informational diversity negatively impacts software quality*	not supported
H5a: *Task conflict negatively impacts software quality.*	not supported
H5b: *Relational conflict negatively impacts software quality*	not supported
H6a: *Task conflict negatively impacts interaction quality*	not supported
H6b: *Relational conflict negatively impacts interaction quality*	supported
H7: *Interaction quality positively impacts software quality*	supported
H8: *Task conflict positively impacts relationship conflict*	not supported

Informational diversity does not impact software quality directly (H4), indicating that informational diversity is not detrimental, but indirectly promotes software quality through the chain of task conflict and learning. Of the remaining significant links, relationship conflict is mediated by interaction quality as an input to software quality (H6b and H7) and learning as an input to software quality (H2b and H3). The control variable, demographic diversity, is significant only in the determination of relationship conflict. The presence of relationship conflict appears to be fully mediated by the combination of interaction quality and learning. No other links are significant in the model.

V. Discussion and Conclusion

Many of the problems associated with SD projects are attributed to conflict resulting from the diversity of project team members. Conflicts are often considered to mediate the relationship between member participation and system outcomes. Barki and Hartwick [13] attempted to resolve the existence of a negative relationship between conflicts and project outcomes, and showed a negative relationship between interpersonal conflicts and project outcomes, regardless of how the conflicts were managed. Based upon their empirical results, they questioned the suggestion in the normative literature that some conflict can be stimulating and beneficial [54]. Thus, they raised the question whether SD project teams should consist of members with different educational and functional backgrounds.

The contribution made by this study further establishes a path from informational diversity to improved software quality through the conflict and learning that occur due to diversity. As task-related arguments increase, project team members may find that they are better able to critically assess and learn information related to their work from each other, a link that has been elusive in prior studies. In addition, informational diversity does not increase relationship conflict, indicating the isolation of informational diversity from increasing the more detrimental form of conflict. What relationship conflict exists in a system development can be negated by the benefits of quality interaction and learning.

SD managers must be aware of the potentials that exist. Each of the primary variables in the model can be addressed in the building and preparation of teams. Informational diversity is measured primarily as a feature for educational background of each team member and functional area of the organization from which a team member hails. These virtues are sufficient to show that SD projects need to structure teams for informational diversity to foster learning and improve the software product. The builders of a project team should consider such variety in the selection of members. This may have implications going back to the hiring practices of an organization, but is more likely addressed in the project time frame. Bringing in members to the team from other functional areas is a good advice, but not always practical as the amount of effort required from members of other departments may require excessive downtime or inattention to their primary jobs. Organizations might consider nontraditional structures where software developers spend some of their time assigned to functional departments as interns, observers, or user liaisons in order to build informational diversity. Similarly, sending the system development members to training in functional areas outside their own expertise will add breadth to their knowledge. This latter might be more crucial than in-depth training in technical subjects, though we do not advocate risking currency in the technical fields.

Organizations must also be prepared to capitalize on the informational diversity and resulting conflict over task. In the model, learning presents an opportunity to promote the desired results and should be an environmental goal. Here, learning is not the attainment of knowledge by team members from training or education; it is the ability to share knowledge with other team members to generate effective solutions to problems. Aspects of autonomy and culture are able to promote a learning environment, which will allow the SD team to realize the learning needed to turn conflict to the benefit of the organization. Moving the organizational culture toward learning can be accomplished through a supportive environment, concrete learning processes, and leadership behaviors [55]. The literature is replete with how to improve the organizational climate and processes to promote learning [56].

However, even though there is an indirect link from informational diversity to final software quality, there is no mitigation of the potential damage created by relationship conflicts. In fact, relationship conflict can lessen team learning, thus reducing one benefit of the task conflict. Managers must be prepared to lessen the effects of this negative impact beyond creating teams with a wide variety of backgrounds and experience. To reduce this effect, managers may focus on the quality of interaction among team members. Certain team practices during development can help lower resulting conflict. Disagreements should be brought out immediately and discussed only if the resulting decision might vary in the result. Limits to disagreement duration should be placed and all members must agree to abide by the decision and work toward its implementation. This can be done as teams go through the forming stage to set parameters for negotiation and resolving conflicts [57].

To build interaction quality, managers should create a cohesive team through activities before and during the course of the project. A knowledge diverse team should reach an agreement on the approaches and methods so that discussions are focused on the product, perhaps as part of a preproject partnering process [58]. Partnering establishes rules of conduct for the team, and can serve to build the trust essential in open communications. During the project, activities can range from the small, inexpensive happy hour gatherings and pizza parties to the more expensive formal retreats. These can all improve the climate for interactions among team members. Other routine managerial actions, such as holding regular meetings with customers and management, should be designed to keep the team focus on the objectives of the project.

As a last point, team size is important [36]. The better core size is from five to seven team members. These core team members are those with critical tasks throughout the different stages of the project while having parttime members with specific skills involved only in a limited number of tasks. Smaller groups present more intensive opportunities to forge into a common collective, or identify and correct potential problems. Having a closely knit core group can serve as a base for the entire project, minimizing the impact of relationship conflicts among the noncore members to brief phases of the overall project.

This study has limits like any cross-sectional survey research. Here, the potential interaction effects among diversity types are neglected. It is possible that they are closely linked and may overlap or influence one another [35]. Second, the cross-sectional design adopted in this study limits its ability to untangle causal relationships in the proposed model. Not only does conflict influence team members' learning but past learning experience may encourage the openness of discussion and interactions among members, thus allowing more opportunity for conflict to occur and affect its members. Furthermore, if members realize that their arguments and debates enhance their decision making and learning, they are more liable to like the other members of the group and plan to work together in the future, and they will be less likely to have relationship conflicts. Data limitations include being collected strictly from within the development teams, who may bias the view of software quality, though quality control is the responsibility of the project team in SD and an unbiased perspective is crucial to organizational health. In addition, data collection in Taiwan might limit the ability to extend the results to other cultures, though again, the criteria selected are more technical and less cultural dependent. Nonetheless, the findings of the study have shed much light on the role of information diversity and learning in SD team management.

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