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Balancing Efficiency and Flexibility in Software Project: The Role of Team Collective Improvisation, behavioral integration, and member diversity

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The successful management of software (SW) projects is a continuous concern to managers, which is attributed to the contradictory demands that most projects are facing; meeting user requirements within time and budget limit while flexibly dealing risks during the progress of the projects. The present study asserts project performance and risk mitigation are not trade-off but to be achieved simultaneously, which is called SW project ambidexterity. Drawing on the literature on organizational behavior, hypotheses are developed speculating the relation among project performance, risk mitigation, team collective improvisation, team behavioral integration, and team diversity. Using empirical data collected from 102 SW project teams of 507 team members in South Korea, empirical analysis indicates team collective improvisation is a significant antecedent to SW project ambidexterity, playing a pivotal role to balance the contradictory demands. Furthermore, team behavioral integration positively influences the degree of team collective improvisation, and the magnitude of the relation is partially contingent on the team members' age and major diversity. The present study advances theory by providing a context specific explanation about the SW project ambidexterity and its precedents.

Keywords: Ambidexterity, Organizational Improvisation, Project management, Team Behavioral Integration, Team Diversity;

Introduction

Since the software (SW) development is in a high-risk industry (Faisal et al. 2006; Karlsen et al. 2006), it has been an interesting research subject in the project management literature. According to the report from the Standish Group, 26 percent of SW projects have been cancelled or abandoned and 46 percent of projects experienced cost and time overrun. Well known causes of this problem are inherent risks of the SW project such as technological

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complexity (Simsek et al. 2006), uncertainty (White 2006), and changing user requirements (Cerpa and Verner 2009). Therefore, identification and preparation for this inevitable risk are becoming important issue in the SW project management literature (e.g. Boehm 1991, Raz and Dvir 2002).

The successful project management requires tradeoff between making steady progress with scope, cost, and schedule constrains and mitigating various emerging risks. Unfortunately, simultaneous pursuit of both goals is a mandatory situation in most cases. Therefore, managers in the SW project face a contradictory demand; meeting customer requirements within time and budget limit while minimizing risk by flexibly adapting changes during the progress of the projects. To this end, early researchers has mostly relied on the development methodology with an attempt to integrate both traditional and agile method (Vijayasarathy and Turk 2008; Vinekar et al. 2006) and find a solution for the equilibrium between mutually competing developing mechanism, which is called SW development ambidexterity (Magni et al. 2009; Tiwana 2010). However, the call for ambidexterity in SW projects is far beyond the mere adoption of certain types of development methodology. The inherent risks in SW project require managers to find an overarching management tactics for the balance between efficiency and flexibility. In other words, an immediate balancing mechanism should be working throughout the project lifecycle where all the team members take the risk of deviating from the planned solution and at the same time the manager controls not to let project activities become totally unstructured (Magni et al. 2009).

The present study defines SW project ambidexterity as achieving both high level of project performance and risk mitigation based on the specific capabilities for the successful management of the mutually contradictory demands: efficiency vs. flexibility, alignment vs. adaptation, traditional vs. agile development method (Lee et al. 2006; Napier et al. 2011; Tiwana 2010; Vinekar et al. 2006). However, we are not given a clear answer regarding how to develop capabilities for the ambidextrous outcome of the SW project. Previous project management literature has been only focused on the relationship between project performance and static nature of the project team such as team composition (e.g. Faraj and Sproull 2000), team member personalities (e.g. Bradley and Hebert 1997; Gorla and Lam 2004; Howard 2001), and attitudes (e.g. Han and Hovav 2013; Mitchell 2006; Parolia et al. 2007). A specific skill sets or behavioral orientations for achieving both project performance and risk management deserve more research attention.

Drawing on the literature on organizational behavior, the authors introduce team collective improvisation, team behavioral integration, and team diversity as important team level antecedents to the SW project ambidexterity. The rest of the paper is organized as follows. The extant literatures are reviewed on the emerging concept of team collective improvisation thereby research model and hypothesis are suggested. Next, the analysis results are reported with empirical test. Finally, contributions to theory and practice as well as limitations of the study are discussed.

Theory and Hypotheses

Team Collective Improvisation

Organizational improvisation is largely based on the metaphor from jazz music and theatre Kamoche and Cunha 2001; Moorman and Miner 1998; Weick 1993). In the Jazz or theatre literature, improvisation refers to the musicians or actors' engagement in spontaneous acts which are largely dependent on interaction with the audiences in a moment, extemporaneous, unexpected, and unplanned way (Ciborra 1999a). The concept of improvisation has been introduced in the field of organizational behavior to explain a specific capability of organizations responding to situation where planned routines are not possible or not effective (Weick 1993). Similar to jazz or theatre situation, organizational improvisation depicts the system of interaction where at least two agents interact to compose while executing (Moorman and Miner 1998).

In the Information System (IS) and project management literature, conceptual discussions and anecdotal evidences have been reported. Ciborra (1999b) proposes that improvisation is not just a fluctuation in regular organizational routines, but a practice which is supposed to prevail through overall governance of information system design. Dyba (2000) argue that improvisation approach is necessary condition in order for SW organizations overcome challenges to balance the refinement of the existing skill base with the experimentation of new ideas to find alternatives.

The relevance of improvisational practice to the SW project team is attributed to the inherent nature of SW project: time constraint, unpredictability, and complexity (Dyba 2000). Time constraint refers to the usual phenomena in SW projects when time planning and budget allocations are fixed at the beginning of the project. Unpredictability is related to the fact that the requirements defined at early stage will eventually change, and lead to the change in the project schedule, budget, and other resources (Han and Huang 2007; Keil et al. 1998; Turner and Cochrane 1993). Complexity arises when a project involves multiple stakeholders or adopts new technologies which have potential risk to the successful adoption to organizations.

The inherent risky situations in SW project are consistent with what organizational improvisation literature is pointing as turbulent environments where improvisational behavior is required (Chelariu et al 2002). Moorman and Miner (1998) point two criteria when improvisation can be valuable and effective. First, improvisation can be an effective choice when 'a firm faces environmental turbulence that requires action in a time frame that is shorter than a regular planning cycle'. Second, improvisation might be prompted when 'planning has not provided all the details or tactics of implementation' (p.3). The traditional top-down, engineering approaches to SW projects may not effectively deal with this contextual peculiarity (Magni et al. 2009). Thus, project team members (including system developers) should be able to proactivity interpret emergent specifications and fulfil the emergent requests for customization, capturing, and integrating extemporaneous ideas emerging within project participants (Ciborra 1999b).

Likewise, SW developer's improvisation balance traditional development methods and extemporaneous behavior to face the project and users' emergent needs (Magni et al. 2009). For example, developers occasionally combine hardware or software artefacts which were not part of pre-planned resources. Sometimes, even neglected existing development platform may be reused when compatibility issue emerged during the implementation of new equipment and integration with legacy system to prevent project delay (Moorman and Miner 1998). The present study expands this view providing that improvisations in SW projects is a collective behavior of a team rather than only the impact of individual developer's improvisational behavior (Moorman and Miner 1998).

Based on the above discussion, the authors propose team collective improvisation in SW projects plays an important role in minimizing project risk and at the same time adhering to planned schedule, budget, and quality requirements. Thus following hypotheses are suggested.

H1: The team collective improvisation is positively associated with SW project ambidexterity

Team Behavioral Integration and Team Collective Improvisation

Although the team collective improvisation often builds on and incorporates individual competency, individual improvisation alone is not sufficient for the collective improvisation. Instead, the joint activities of individual people create a collective system of improvisational action (Moorman and Miner 1998). Moreover, a person's behavior, whether planned or improvisational, occasionally provoke collective activities that are improvisational (Burgelman 1983; Hutt et al. 1988). Although team collective improvisation results from individual behavior that is itself highly extemporaneous (Mintzberg and McHugh. 1985), the individual improvisation must move on to the organizational level for a collective improvisation to occur (Moorman and Miner 1998). Therefore, a high level of interactions among team members is required for the team level improvisation to satisfy emergent needs.

Team behavioral integration is defined as 'the degree to which the group engages in mutual and collaborative interaction' (Hambrick 1994). It is conceptualized as a metaconstruct capturing three interrelated processes that characterize the team behavioral integration: (1) joint decision making, (2) collaborative behavior, and (3) the quantity and quality of information exchange (Hambrick 1994; Simsek et al., 2005)

Moorman and Miner (1998) stated that systems of interaction and mutual adaptation are factors that influence the effectiveness of improvisation, a team with highly behavioral integration satisfies these conditions. Behavioral integration enhances real-time information flows through which members learn the consequences of their actions and make it easy to replace the coordinating role of a plan when actors improvise to the same incoming information. The collaborative work and joint decision making of highly integrated team can develop mutually adaptive interactions in which knowledge of the work was developed as the work unfolded (Moorman and Miner 1998).

Many organizational literature has been empirically demonstrated the relevance of the

behavioral integration in a situation characterized by rapid and unexpected changes (Carmeli, and Schaubroeck 2006). It is found that behavioral integration provokes the combination of knowledge to respond to the environmental needs (Hambrick 1994). Likewise, the behavioral integration also facilitates innovative product development by exchanging, coordinating, and aggregating individual contributions (e.g. Han and Huang 2007). Similarly, the effect of quantity and quality information flow on SW project performance has also been empirically demonstrated. In an emergent problem situation, SW project team should integrate individual capabilities to solve problems through an emergent process of informal interactions and sharing of expertise (Faraj and Sproull 2000). Good quality in the team communication allows team members to obtain relevant information in a short time frame.

Based on the above arguments, following hypothesis is suggested.

H2: The behavioral integration of SW project team is positively related to team collective improvisation

Team Diversity and Team Collective Improvisation

Team composition in SW projects is a prime issue as to whether there is value in the diversity. It has been known that team composed with members who have diverse knowledge background are more likely to engage in creative processes, such as building, experimenting, and elaborating ideas with one another (Somech and Drach-Zahavy 2013). Team diversity is defined as 'the distribution of differences among the members of a unit with respect to a common attribute such as tenure, ethnicity' (Harrison and Klein 2007).

Literature on team diversity classifies it into two categories: social diversity and task-related diversity. Social diversity includes demographic characteristics such as gender, race, age, and nationality (Van Knippenberg et al. 2004). According to social categorization perspective (Van Knippenberg and Schippers 2007), differences between work group members may engender the classification of others as either similar or dissimilar. Because people tend to favor similar members over dissimilar members and to be more willing to cooperate with them, social diversity in a tem is generally recognized as having negative effect on the social integration and communications (Williams and O'Reilly 1998). Task-related diversity perspective is more likely in support of positive role. It refers to the diversity in skills, knowledge, perspective, educational background, and so on. It is regarded as having positive effect to the team by facilitating information exchange and communication from different viewpoints (Nonaka and Takeuchi 1997) and enables elaboration of task-relevant information—the exchange, discussion, and integration of ideas, knowledge, and insights (Kearney and Gebert 2009).

The empirical evidence reported in the SW project literature shows that the relation among social and task-related diversity and SW project performance is mixed (e.g. Liu et al. 2011). Mostly, the effect is contingent upon the selection of the measurements, combining other teamwork constructs such as team cognition, conflicts, and the cultural background, which would play an intermediary role (e.g. Kang et al. 2006; Kearney et al. 2009; Liang et al. 2010).

Therefore, in the context of SW project team improvisation, the authors focus more on the moderating effect of team diversity rather than direct effect in two reasons. First, in terms of social diversity, social categorization might invoke relational conflicts which will consequently have detrimental effect on the quality of team members' interaction (Liang et al. 2010). The task-related diversity, on the other hand, would reinforce the positive relation between team behavioral integration and the team collective improvisation. Considering improvisation is a special case of deviation from existing practices or knowledge (Moorman and Miner 1998) and improvisation relates to explorations and exploitation of 'resources' including organizational experience and knowledge (Cunha et al. 2009), knowledge acquired from diverse previous experience or perspectives would be easily retrieved to find a solution for the current project only when members exchange relevant knowledge. The mere presence of individuals with diverse knowledge is not a sufficient condition for a SW project team to achieve quality performance (e.g. Faraj and Sproull 2000). Thus, the value of the team diversity can be realized only when team members collectively utilize their unique expertise along with others' knowledge (Nonaka 1991).

Based on the above arguments, following hypothesis is developed.

H3: The more a team composed of socially diverse members, the lower the positive relation between team behavioral integration and collective team improvisation

H4: The more a team composed of diversely task-related members, the higher the positive relation between team behavioral integration and collective team improvisation

Research Design

Research Model

Based on the hypothesis development, this study examines two categories of antecedents of SW project success. The first part of the causal links investigates the role of the team collective improvisation on the simultaneous pursuit of risk mitigation and overall project performance. The second part is to examine the facilitative conditions when team improvisation frequently occurs. It is speculated that the team behavioral integration increases the likelihood of the team collective improvisation whereby team diversity will be considered to act as a moderator on this relationship. The conceptual model is presented in Figure 1.

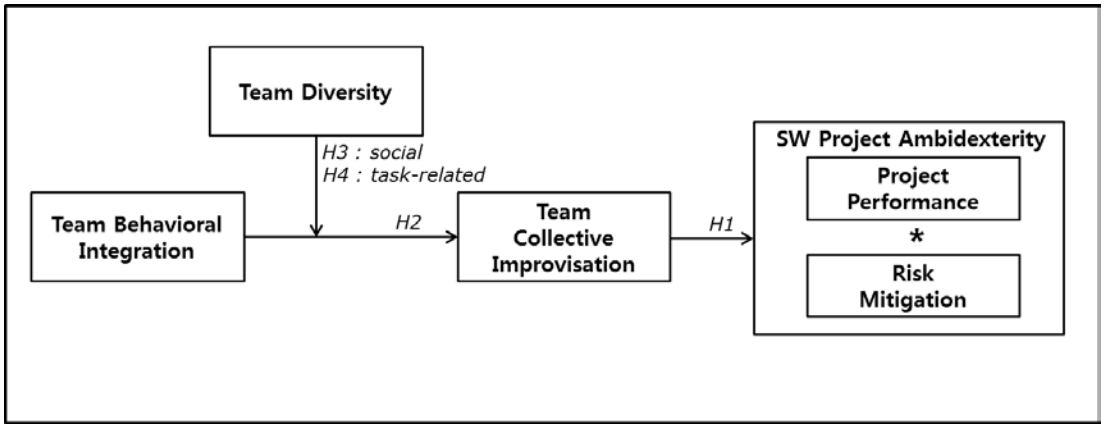


Figure 1. Research Model

Data Collection

The unit of analysis of the present study is a SW project team. In practice, there is no proven way to know the total size of the population of SW projects. Due to this difficulty in systematic sampling from the hidden population, previous SW project team research usually relied on a convenience sampling approach (Elbanna 2006; Faraj and Sproull 2000; Teoh et al. 2012). One example of sampling approaches would be picking one large scale company running multiple teams of specializing SW project (He et al 2007). This approach has a potential bias that the selected company would have a contextual effect on the research subjects. Thus, the present study employed a respondent-driven sampling approach to select research subjects from multiple companies and to obtain asymptotically unbiased estimates. An initial list of SW project managers and their contact were gathered from four major public organizations which place the most part of SW outsourcing project orders in public sector in South Korea. As recommended by Heckathorn (1997) it is assumed that those best able to access project managers from hidden populations are their own peers (p.178). The authors sent an e-mail them for answering survey along with referring other SW project managers preferably in the private sectors who share the characteristics that make them eligible for inclusion in the study. The authors repeated the snowballing until the sample reach to a meaningful size. A dual incentive system was applied by providing an incentive for participation (answering our direct request to answer survey), and also provided additional reward for recruiting others into the study (Heckathorn 1997; Salganik and Heckathorn. 2004). All selected project managers were firstly asked to pick one project which was completed within six months. They were asked to answer the project level survey and also asked to distribute and collect individual level surveys to team members who had joined the project. A total of 122 usable team response data were collected from March 1st to June 26th, 2015.

To ensure the validity of the project team data, following previous team level studies, three criteria were adopted to the selected projects: (1) The project must have at least three members (Kearney and Gebert 2009), (2) More than 50% of the team members should respond (Liang et al. 2010), (3) Project manager or team leader must respond (Liang 2007). Twenty one team data were dropped using this criteria. Thus, the usable sample was finally composed of 102

project teams of 507 team members. Individual response rate with respect to the total number of members who joined the project is 73.3%. The team size ranged from 4 to 30 members (M=8.2) and mean project duration ranged from 2 months to 76 months (M=16.5). Project amount ranged from 0.5 billion KRW to 100 billion KRW (M=11.5). Table 1 reports overall descriptive statistics of individual and team level sample respectively. Industries of the SW project expertise are distributed in various sectors such as manufacturing, public, finance, and science.

Measurements Development

SW Project Ambidexterity: In the organizational ambidexterity literature, ambidexterity is usually measured by its sub-component measures which are dichotomous in nature, for example, exploitation vs. exploration (Lin et al. 2007; Lubatkin et al. 2006; Rai et al. 2002). As the present study operationalized SW project ambidexterity as achieving both high level of project performance and risk mitigation, measurements were developed using combined dimension of the two subcomponents. The final observed value of SW project ambidexterity is calculated by multiplicative interaction between project performance and risk management, which sub-measurements are to be discussed below (Lubatkin et al. 2006).

SW Project Performance: In general, project success is determined whether the project has achieved its overall objectives such as user satisfaction or adding business value to the organization (Delone 2003). On the other hand, project success is also related to the project management success, measuring whether cost, schedule, and quality has been satisfied against plan (Cooke-Davies 2002). The current study focuses on the project management success rather than overall success of the project. Also, the term SW project performance encompasses product performance aspects and process performance aspects (Nidumolu 1995). Product performance refers to whether the amount and quality of the delivered system meets the user requirements and process performance refers to whether the project is completed within the budget and schedule. While product performance is the primary factors in the most SW developments, projects have to trade it off time and budget limitation. Thus previous studies usually adopted consolidated measurements between product and process performance as general indicators (e.g. Harrison et al. 1998; Jones and Harrison 1996; Liu et al. 2011; Parolia et al. 2007). Thus, the present study defines SW project performance as an overall outcomes in terms of goals, products, quality, schedule, efficiency, and budget.

In order to overcome the challenges in determining a uniform measure for the SW project performance, the present study used perceptual indicators as generally adopted by previous literature (Faraj and Sproull 2000; Liang et al. 2012). The performance measurements were constructed with six items to rate the extent to which the project team met project goals, expected amount of work produced, quality of the deliverables (product performance), and the extent to which project's adherence of schedule, budget, and efficiency of task operation (process performance). All items were measured using a five point Likert-type scale ranging from 1(very low) to 5(very high). The performance ratings are gathered from project managers only. In the case of outsourced projects, the authors located the project managers in the client side (i.e. customer) and asked them to rate the overall performance of their projects. In case

when project managers are absent or contact information are limited, the authors asked the project manager in the provider side for rating.

Table 1. Descriptive Statistics of project team and team members

Project Team		Freq.	%
SW Project Type	Consulting	25	24.5
	Integration	23	22.5
	Development	11	10.8
	Maintenance	1	1.0
	R&D	36	35.3
	Authentication	1	1.0
	Other	5	4.9
Duration	~5 Months	23	22.5
	6~11 Months	31	30.4
	12~17 Months	13	12.7
	18~23 Months	2	2.0
	24~29 Months	9	8.8
	30~35 Months	3	2.9
	36 ~ 41 Months	15	14.7
	42~ Months	6	5.9
Amount (KRW)	~ 5 Billion	23	22.5
	6~9 Billion	26	25.5
	10~14 Billion	17	16.7
	15~19 Billion	1	1.0
	20~49 Billion	29	28.4
	50~ Billion	5	4.9
	Missing	1	1
Industry	Manufacturing	15	14.7
	Construction	1	1.0
	Energy	13	12.7
	Retail	1	1.0
	Public	38	37.3
	Finance	4	3.9
	Science	18	17.6
	Education	1	1.0
	Others	11	10.8
	Total	102	100

Team Members		Freq.	%
Gender	Female	82	16.2
	Male	425	83.8
Age	20~24	20	3.9
	25~29	94	18.5
	30~34	127	25.0
	35~39	101	19.9
	40~44	110	21.7
	45~49	37	7.3
	50~54	9	1.8
	55~	9	1.8
Tenure	~ 4 years	161	31.8
	5~9 years	106	20.9
	10~14 years	122	24.1
	15~19 years	80	15.8
	20~24 years	24	4.7
	25~29 years	7	1.4
	30~ years	7	1.4
Education	High School	12	2.4
	Undergraduate	310	61.1
	Master	134	26.4
	Doctor	51	10.1
Expertise of Industry	Manufacturing	55	10.8
	Construction	4	.8
	Energy	17	3.4
	Retail	5	1.0
	Public	114	22.5
	Finance	27	5.3
	Science	167	32.9
	Education	1	.2
	Art/Sports	3	.6
	ICT	97	19.1
	Other	17	3.4
Total		507	100

***Risk Mitigation**:* Recent empirical studies classify SW risks into 6 dimensions: user, requirement, project complexity, planning & control, team, organizational environment (Han and Huang 2007; Wallace et al. 2004a; Wallace et al. 2004b). However, considering the causal relationship between the constructs in the research model, the present study focused risks dimensions which would possibly occur only during the execution of the projects, thus excluding those which are inherent and not controllable after projects initiated such as project complexity, team members' competency (Wallace et al. 2004b). Thus, risk mitigation is operationalized as the degree to which SW project mitigate risk in terms of customer, requirement, technology, environments. Customer risk refers to the changes in client organizational structure, politics, business process, and user involvements (Keil et al. 1998; Xia and Lee. 2004). Project Scope risk refers to the changes in scope and requirements during the execution of the project (Wallace and Keil 2004; Keil et al. 1998). Technology risk refers to the changes in technical architecture, compatibility, and/or other unanticipated technical or methodological issues (Xia and Lee. 2004). Finally environmental risk refers to the project environmental changes such as planning and control, member turnover (Wallace et al. 2004a).

For each dimensions of project risks, measurement items were developed using 5-point Likert scale. To measure how the team mitigated risk during the project, respondents are asked to rate the degree of actual occurrence of the risk and the degree of how well the team responded it for of each dimension. Final score of each risk mitigation dimension was computed by the multiplication of the score from the occurrence of the risk and score from the response to the risk and divided by five to maintain variance consistency with the project performance score.

***Collective Team improvisation**:* Drawing on the previous organizational improvisation literature, the effective team improvisation is known to have three subdimensions: novelty, spontaneity, and bricolage (Cunha et al. 1999; Vera and Crossan 2005).

Novelty is operationalized as the degree to which the project team tries to solve problems during the project in a new way or with deviation from pre-established process (Xia and Lee 2004). Spontaneity is operationalized as the ability to respond to the problems on the spot (or in real time) during the project (Unger and Kernan 1983). Bricolage is operationalized as the frequency by which the team rearranges whatever resources at hand in order to craft a viable response to the emergent problems (Teoh et al. 2012). Each measurement item consists of four questionnaires which were adopted from previous literature and modified to fit in this research subject

As argued in the previous studies (e.g. Leybourne and Sadler-Smith 2006), organizational improvisation is a multidimensional construct and effective improvisation is recognized only when the key aspects are highly manifested at the same time. For example, novelty does not imply improvisation when there is enough time or when there are plenty of available resources for finding solution. Therefore, the author suggests SW project team's collective improvisation can be best described by the combined magnitude of three key aspects.

***Team Behavioral Integration**:* A Four-item scale from Li and Hambrick (2005) and Magni et al (2009) was used to measure dimensions of team behavioral integration using 5-point Likert

scale. Respondents are asked to rate how much the project team is characterized by open and fluid communications among team members, sharing experience and expertise, collective exchange of points of view, and respect of suggestions and contributions of team members.

Team Diversity: Each project team members were asked to provide information about their gender, age, the academic field in which they had obtained their highest degree, years of total job experience, and industries of expertise. Among these demographic variables, following previous similar studies, gender and age are included in the social category diversity measure and the level of education, years of job experience, educational backgrounds, and industries of expertise are included in the measurement group for knowledge diversity. As performed in the similar studies (e.g. Kearney and Gebert 2009), each diversity dimension was measured using Blau's index of heterogeneity ($1 - \sum p2i$) [4]. In this formula, p is the proportion of a team in a category and i is the number of different categories represented on the team. The index varies from 0, which indicating no diversity, to a theoretical maximum of 1. Categorization was required for ratio data such as age and years. For the age diversity, we categorized respondents by eight increments (i.e., 20~24, 25~29, 30~34, 35~39, 40~44, 45~49, 50~54, 55~). Likewise, years of job experience was categorized by 7 increments for the tenure diversity (i.e., ~ 4 years, 5~9 years, 10~14 years, 15~19 years, 20~24 years, 25~29 years, 30~ years).

Control Variables*:* The researcher included several control variables that prior research has identified as having association with SW project performance. Team size, referring the number of team members involved in the project, is related to the team collective improvisation and team behavioral integration (e.g. Akgün et al. 2007). Project budget which is the amount of money funded to the project, and project duration is also adopted to adjust the difference in effect size of team improvisation on the project performance. Target industry of each SW project is also adopted to identify group difference among various industry specific environments.

Except for the control variables and team diversity, each variable is structured with multiple survey instruments. To assess overall adequacy of survey instruments a pretest was performed by fifty SW professionals, who are randomly selected from the panels of a web-based survey agency in South Korea. A preliminary factor analysis was performed and some questionnaire items which have low level of factor loading or multiple loading were modified.

Analysis and Results

Construct Validity of Individual Level Measurements

An initial exploratory factor analysis (EFA) was performed to assess the validity of the constructs. Although the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.929 and Bartlett's test of sphericity was satisfactory ($p<.001$), the results indicated some of the scales to be removed. One item for improvisation (spn_4) showed low level factor loadings which values are below generally recommended threshold (<.05). A final four-factor structure emerged which explaining total 71.3% of variance.

Next, a confirmatory factor analysis (CFA) using AMOS 21 software was performed for the individual level data and confirmed that the survey items represented seven latent constructs as expected. Reliability of each construct was verified through three indicators. All Cronbach's alpha coefficients and composite reliability (CR) values are highly satisfactory above desired value 0.7 (Hair et al. 2006), average variance extracted (AVE) indices also exceed minimum standard of 0.5 Hair et al. 2006. For the convergent validity, all measurement items loaded on their hypothesized construct factors significantly, which standard factor loadings are significantly all above the recommended threshold 0.4 (Ford et al. 1986). Discriminant validity was also verified as the square root of the AVE is larger than the correlations with other constructs (Fornell and Larcker 1981).

To test the multidimensionality of team collective improvisation, the study compared first-order factor model with four individual factors to the second-order factor model with two factors: team improvisation with three sub-constructs (novelty, spontaneity, bricolage), and team behavioral integration (first-order factors maintained). CFA results indicates that there is no significant difference in the fit indices and each fit index for second-order model are also beyond recommended threshold, treating second-order model is assumed to be justifiable. The results also indicated the loadings of the measurement items on the first-order factors (novelty, spontaneity, and bricolage) and the loadings of the first-order factors on the second-order factor (team collective improvisation) were all significant at $p < .01$. The statistical results also imply there is positive and significant relationship between the second-order-factor and its first-order factors.

Construct Validity of Team Level Measurements

Among the team level constructs, measurements for project performance and risk mitigation which data were collected by project team managers need to be separately tested for construct validity. The EFA results showed that Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.804 and Bartlett's test of sphericity was satisfactory ($p<.001$). Two-factor structure emerged explaining total 56.01% of variance. Six measurement items for project outcome are converged onto single factor, and four items for risk mitigation are converged onto single factor as expected. Reliability of each construct was verified through Cronbach's alpha coefficients, which values of each constructs are highly satisfactory above desired value 0.7 Hair et al. 2006. Team diversity measurements – age, gender, level of education, major, industries of expertise – will be applied as a single measurement. Therefore, they are excluded in the validity assessment.

Item Aggregation

For the efficiency and parsimony of the causality analysis, researchers prefer unidimensional scales when integrating values into a broader nomological network (Ulaga and Eggert 2006). Multidimensional indicators in the present study which were collected from team members need to be aggregate to team level. The present study employed frequently used methods in the previous research, using factor loadings weighted mean (e.g. Raz and Dvir 2002; Ulaga and Eggert 2006) to calculate single indicators for each constructs with multiple indicators. For high-order constructs (team collective improvisation), a hierarchical parceling was conducted using standardized factor loadings.

Hypothesis Test

Table 2 presents the means, standard deviations, and correlations among variables. There are positive and significant correlations among project performance, risk mitigation, team improvisation and team behavioral integration. None of the diversity variables is significantly correlated with project performance or risk mitigation. Only educational and major diversity shows significant correlation to team collective improvisation ($p<0.01$). Among control variables, only project duration is positively correlated to project performance, team collective improvisation, and team behavioral integration.

Table 2. Correlations among variables

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
Project Performance	3.76	.637											
Risk Mitigation	3.51	.630	.439**										
Team Improvisation	3.65	.431	.439**	.296**									
Behavioral Integration	3.77	.538	.473**	.203*	.763**								
Gender Diversity	.21	.198	-.074	.045	-.055	-.095							
Age Diversity	.61	.128	-.128	-.126	.000	.004	.256**						
Education Diversity	.38	.220	.138	.107	.294**	.252*	.015	.232*					
Major Diversity	.59	.170	-.149	-.004	-.257**	-.172	.084	.132	-.033				
Industry Diversity	.27	.250	-.152	-.004	-.157	-.119	.095	.124	.092	.177			
Amount	11.91	18.28	.152	.140	-.009	.015	-.029	.078	.159	-.225*	-.075		
Duration	16.85	15.94	.195*	.135	.341**	.286**	-.141	-.085	.142	-.410**	-.156	.351**	
No. of team member involved	8.20	4.50	.160	.166	.085	.034	.046	.068	.085	-.019	-.048	.260**	.210*

**Significant at the $p<.01$ (2-tailed); *Significant at the $p<.05$ (2-tailed)

The first multiple regression analysis (see table 3) posits SW project ambidexterity as a dependent variable which observed value was calculated by multiplicative interaction between project performance and risk mitigation. The results indicate there is a significant effect of team collective improvisation on the SW project ambidexterity ($b=2.739$, $t=2.295$, $p<.01$), thus supporting hypothesis 1. Team collective improvisation explains 30.5% of variance in SW project ambidexterity. None of the control variables explain significant variance in the dependent variable.

Table 3. Multiple Regression Analysis I

Model		Dependent Variable : SW Project Ambidexterity (project performance * risk mitigation)	
		Control	Main Effect
1	Amount	.018(.085)	.031(.143)
	Duration	.028(.114)	-.000(-.001)
	No. of members	.125(.142)	.121(.137)
	Industry-public	-.255(.031)	.021(.003)
	Team Collective Improvisation		2.739(.298)*
	R^2 (Adjusted)	.065(.026)	.305(.220)
	R^2 change		.196
	F change		12.686**

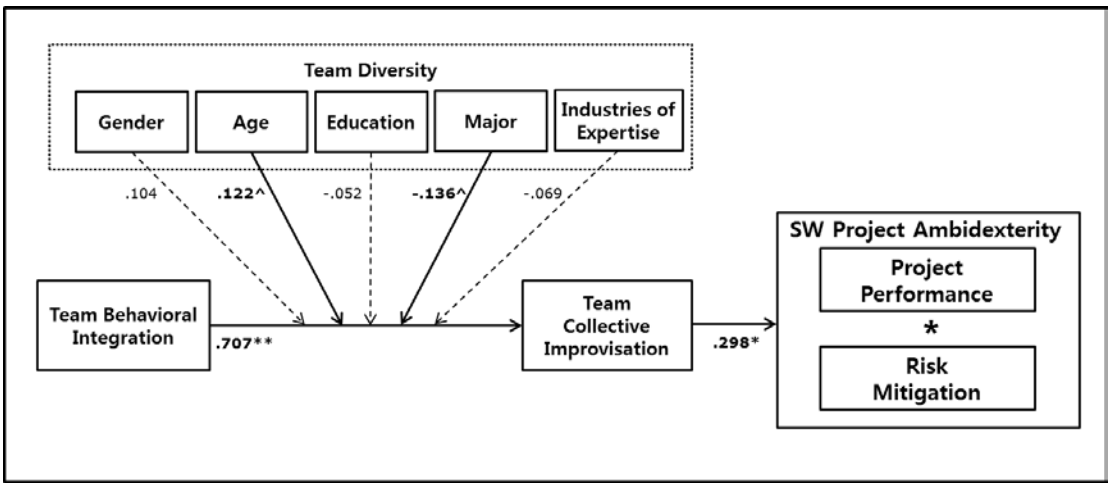
**Significant at the p<.01; *Significant at the p<.05

Table 4. Multiple Regression Analysis II

	Dependent Variable : Team Collective Improvisation		
	Control	Main Effect	Interaction Effect
Amount	-.004(-.166)	-.003(-.118)	-.002(-.104)
Duration	.010(.351**)	.003(.115)	.002(.063)
No.of members	.005(.051)	.005(.053)	.008(.081)
Industry-public	-.115(-.129)	.017(.019)	-.010(-.011)
Gender Diversity(GD)		.076(.035)	.052(.024)
Age Diversity(AD)		-.011(-.003)	.111(.033)
Educational Diversity(ED)		.246(.126)	.159(.082)
Major Diversity(MD)		-.274(-.108)	-.236(-.093)
Industry Diversity(ID)		-.106(-.061)	-.095(-.055)
Team Behavioral Integration(TBI)		.546(.680**)	.567(.707**)
TBI*GD			.047(.104)
TBI*AD			.059(.122)^
TBI*ED			.022(.052)
TBI*MD			-.059(-.136)^
TBI* ID			-.029(-.069)
R^2 (Adjusted)	.152(.117)	.632(.592)	.678(.622)
R^2 change		.480	.480
F change		19.814**	2.426*

**Significant at the p<.01; *Significant at the p<.05

The second multiple regression analysis (see table 4) posits team improvisation as a dependent variable and assess the effects of team behavioral integration and the moderating effect of each team diversity variables on the relationship between team behavioral integration and team collective improvisation. A hierarchical regression analysis with mean-centered predictor variables (Aiken and West. 1991) attained two meaningful results. First, team behavioral integration has significant effect on team collective improvisation (b=.517, t=7.372, p<.01), thus supporting H2. To test the mediation effect, widely accepted method was used as suggested by Baron and Kenny (Baron and Kenny 1986). In the additional hierarchical regression analysis with stepwise inputs of independent and mediator variables, results indicate that team collective improvisation exhibits full mediation between team behavioral integration and SW project ambidexterity. Second, among social diversity variables, only the effect of interaction between age diversity and team behavioral integration is marginally significant (p<.1). Among task-related diversity variables, only the effect of interaction between major diversity and behavioral integration is also marginally significant (p<.1). These results are acceptable as the statistical power for detecting moderators in field studies is inherently low (McClelland et al. 1993), which is similarly reported in the previous research on group diversity (e.g. Harrison et al. 1998). A significant change in the multiple squared correlation coefficients after adding the interaction terms also justifies the moderating effect. However, on the contrary to the authors' expectations, age diversity showed positive interaction effect and major diversity showed negative interaction effect. Thus these results reject hypothesis 3 and 4. Among control variables, project duration was significantly and positively related to team collective improvisation.



** Significant at p<.01, * significant at p<.05, ^ significant at p<.0.1

Figure 2. Analysis Results

Finally, to elaborate the interaction effect between team behavioral integration and team diversity, simple slope analysis (Aiken and West 1991) was conducted. Regressions were conducted at high (one standard deviation above) and low (one standard deviation below)

level of age diversity and major diversity. The results reveal that the relationship between team behavioral integration and team collective improvisation was significant ($p<.05$) and positive in case of either age diversity high ($b = .872$, $t = 9.109$, $p<.01$) or low ($b=.649$, $t=6.613$, $p<.01$), and so is in case of major diversity high ($b = .587$, $t = 6.549$, $p<.01$) or low ($b=.898$, $t=9.896$, $p<.01$). However, the tendencies of interaction effect in two cases are contradictory. When team age diversity is high, the strength of the relationship between team behavioral integration and team collective improvisation is heightened. On the contrary to our expectation, the relationship is weakened when major diversity is high.

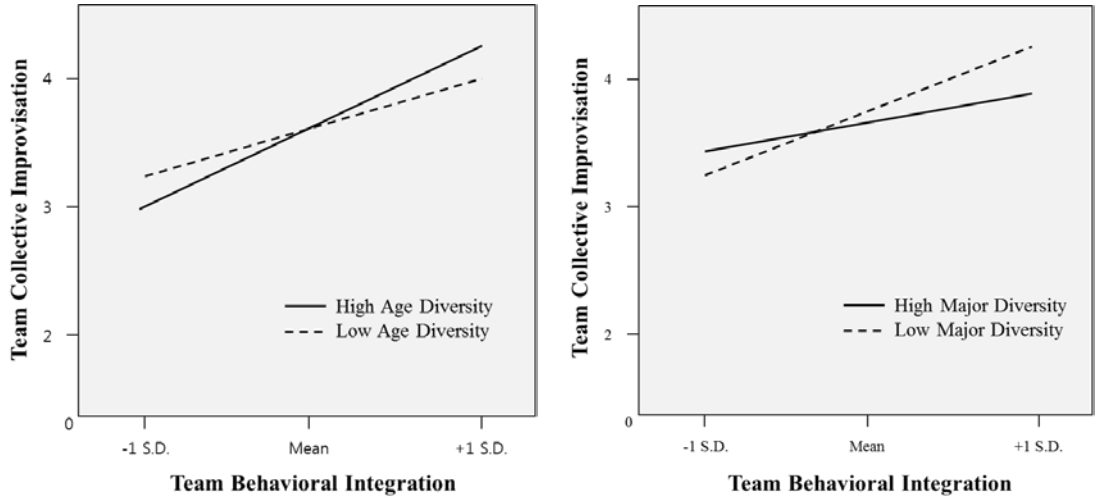


Figure 3. Interaction Effects of Team Diversity variable

Discussion

Theoretical Implications

The major findings from the analysis are consistent with the previous literature viewing improvisational process as an important factor to successful completion of the project (e.g. Dyba 2000; Miner et al. 2001; Akgün et al. 2007; Gallardo-Valencia and Sim 2007; Teoh et al. 2012). The present study extended this view by introducing risk management into another dimension of project success, integrating project performance and risk mitigation which are to be achieved simultaneously. Next, as De Bakker et al. (2010) noted, despite accumulated knowledge about the effect of project risks to the failure of SW projects, we had little empirical evidence regarding how these risks are actually managed during the course of projects. The empirical data from the sample indicates the team collective improvisation plays a pivotal role to mitigate risks while maintaining quality project completion. Thus, the present study makes a theoretical contribution to literature on project management by relating team level improvisation to ambidextrous project success and extending previous studies which has been focused only on the project performance (e.g. Leybourne and Sadler-Smith 2006; Akgün et al.

2007).

Previous project management literature has been continuously paying attention to whether team member diversity has a positive effect on work performance or not (e.g. Liang et al. 2010; Liang et al. 2012). The study found that the age diversity in a SW project team have positive moderating effect between behavioral integration and team collective improvisation. This result is contrary to previous study on team social diversity in information system research (e.g. Liang et al. 2007) or similar organization research (Kearney et al. 2009). The results are interesting since it enlightens our view on the effect of social diversity demanding that we should move on to the context specific explanation. The cultural context might be one possible area of interest (e.g. Kang et al. 2006). Considering the high proportion of males to females of the sample (.838) and the Asian cultural tradition based on age hierarchies, the sample implies that the team with high level of age diversity is efficient in developing and implementing immediate solution and quick feedback. On the other hand, educational background diversity has a significant moderating effect, which is consistent with previous empirical evidence (e.g. Jehn et al. 1999) supporting that differences in educational background are the most critical factor in explaining task-related team diversity. Interestingly, the present study found that educational background diversity restricts positive effect of team behavioral integration on team collective improvisation. One plausible explanation can be that task related diversity is delaying spontaneous response because the members' different perspectives in viewing emergent problems make it difficulties to figure out immediate solution. Task related conflicts among members is worthy of notice that might occur during a team's problem-solving process (Liang et al. 2007).

Managerial Implications

For the managerial point of view, the authors suggest organizations should consider improvisation as a potentially effective skill and tool that complements planning efforts (Vera and Crossan 2006). Specifically, in the SW project, team level capability of dealing with contradictory demands for both efficiency and flexibility (or align and adaptation) is neglected compared to the task related capabilities including technical skill, business knowledge, experiences etc. Managers need to consider recruiting improvisation-oriented employees or developing training program which would strengthen employees' improvisational capabilities, which will be further research subjects. Furthermore, SW project managers may benefit from utilizing the individual level and team level improvisation as team members collectively engage in unanticipated events during the project. The study revealed the team collective improvisation is more than the sum of team members' skill. The full mediations of team collective improvisation on the relationship between behavioral integration and project performance and risk mitigation indicates a systemic team level coordination mechanism should be implemented for an SW project's fully utilization of its resources. Team members together facilitate team collective improvisation especially when they engage in mutual and collaborative interactions enough to counterbalance potential inefficiencies what heterogeneous team would expose. Therefore, managers also need to keep in mind that improvisational capabilities need to be internalized within the team for an ambidextrous project success.

Limitations and Future Research Suggestions

Despite the several important theoretical and managerial contributions, the present study has following several limitations. First, the study relied on the perceptual measurement and retrospective reports of how team improvised during the project. One problem related to this approach is that organizational improvisation with negative outcome is never reported because empirical evidence about successful achievements through improvisation was found after the fact (e.g. Hutchins 1991; Rerup and Center 2001). Moreover, the measurement scale of the present study, although it is a good start for empirical test, only deals with the different aspects (dimensions) of improvisation. A developing objective measurement to assess the degree of the effective improvisation is an interesting future research agenda because this effort would recognize improvisation as something to be measureable and manageable thus to be incorporated with existing project management techniques (e.g. PMI 2008).

The relatively small sample is the second potential limitation notwithstanding the difficulty of sampling from hidden population of SW projects. The moderating effect of social and task-related diversity, some of which were not significant in the current study would be revealed if the sample size increases. A cross-cultural sample will also provide more interesting explanation of how team diversity variables affect differently in each cultural context. Marginal moderating effect of the task-related diversity factor (i.e. educational background diversity) is another motivation for the further research. The results suggest studies adopting a new team level process which would explain how members identify and integrate each other's knowledge during the team improvisation thus speeding up finding solution within the limited time frame.

Lastly, the current study has found a significant correlation between project duration, team improvisation, and team behavioral integration. This implication includes there might be a time effect, meaning that there is a potential increase in team behavioral integration as team members communicate more intimately as the project goes by. Further research adopting longitudinal approach would investigate how project teams shift towards behaviorally integrated along with some other team management tactics applied. Finally, as suggested by Trotter et al.(2012), adoption of qualitative analysis methods would be taken into consideration in the future research in order to obtain in-depth understanding of how individual improvisations will interact each other while potential social- and task-related conflicts reside. All of these things taken together, a systematic and comprehensive understanding is needed regarding how to composite a team with individuals who possess capabilities to deal with contradictory situation and how to encourage them to act as a one team during the improvisational process.

Conclusion

The present study challenges the traditional view of 'engineering principles' to the project management which posits rigorous planning is the only practical solution for the project success. Theory of organizational ambidexterity and improvisation are useful means to support our challenge (e.g. Conradi and Fuggetta 2002). Focusing on the microfoundations of the project team, this study seeks to identify dynamic team process which will serve as a

mechanism to overcome contradictory situations of the SW project and identify how team structure and team process interplay in building the dynamic team process. The results provide empirical evidence that improvisation is not just a temporal measure suited to the specific occasion. We should more modestly appreciate the utility of improvisation and make sense of complex situation. Improvisation may not be only what organizations actually practice but also what they should encourage.

Research on the organizational improvisation is still at an early stage calling for more empirical studies (Kamoche and Cunha 2001; Vendelø 2009). The introduction of the team collective improvisation to SW project management provides us another motivation to current innovation research. The authors hope this paper will stimulate researchers in this filed to be encouraged to afford closer scrutiny to the dynamics, antecedents, and consequences of team improvisation in today's organizations.

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