

# Optimal Team Formation for Practical Software Development Exercise — Evaluating a Method for Team Formation Based on the Type of Project Manager —

KIYOMI SHIRAKAWA, SHIORI YAMAMOTO, RYOTA CHIBA  
HIROAKI HASHIURA and SEIICHI KOMIYA

Graduate School of Engineering, Shibaura Institute of Technology  
Komiya Lab, 13F, Kenkyu-to, 3-7-5 Toyosu, Koto-ku, Tokyo  
JAPAN

k-shirakawa@komiya.ise.shibaura-it.ac.jp, m108122@shibaura-it.ac.jp,  
{chiba, hashiura}@komiya.ise.shibaura-it.ac.jp, skomiya@shibaura-it.ac.jp  
<http://www.komiya.ise.shibaura-it.ac.jp/>

*Abstract:* - In the software development exercise for the third graders of the Shibaura Institute of Technology Department of Information Science and Engineering, students are assigned to each team with the capability to carry out a role, for optimization of team formation. In the team formation of 2006, each student who expected to play an active part for the success of exercise subject played an active part also in the actual exercise lesson in each team. As a result "all the teams achieved the exercise subject without any halfway dropouts", which Shirakawa, et al. [1] checked. However in the questionnaire results after the end of the exercise, it turned out that the low motivation of some students caused the shortage of communication of the members in the team.

Then, the authors built up the hypothesis that "each student's motivation is decided by whether the type of Project Manager (Project Manager is described as PM henceforth) and the PM type each member desire is in agreement. Each member has a role to play besides PM in the team for software development. The decision of the role assignment of each member demanded a substitute characteristic and an expression of relations with each role to express a role performance by a covariance structure analysis. Based on an expression of relations, decided assigned members according to the PM type and performed role assignment and the team formation of each member. As a result, the team formation of the students without the practice experience confirmed that high team formation of the cooperativeness between team members was realizable by considering a PM type.

*Key-Words:* - Optimizing Project Team Formation, Exercises in Units of Groups, Chi-Square test, Exercise for Software Development, Genetic Algorithm, Factor Analysis, Covariance Structure Analysis, Path Diagram, Maximum Likelihood Estimation

## 1. Introduction

In the software development exercise for the third graders of the Shibaura Institute of Technology Department of Information Science and Engineering, students are assigned to each team with the capability to carry out a role, for optimization of team formation. In the team formation of 2006, performed by Shirakawa, et al. [1] each student who expected to play an active part for the success of exercise subject played an active part also in the actual exercise lesson in each team. As a result "all the teams achieved the

exercise subject without any halfway dropouts". However in the questionnaire results after the end of the exercise, it turned out that the low motivation of some students caused the shortage of communication of the members in the team. Therefore in order to solve this problem hypothesized that "it is decided whether the motivation of each student agree with the type of PM (management type or partnership type) and the type of PM desired by each member". In order to inspect the hypothesis for the target students (1st, 2nd grade) of Shibaura Institute of Technology, analyzed









Table 2 The targeted students

Students	the third graders of the Department of Information Science and Engineering
Software development experience	Inexperienced person
Skill of programming	Students who can understand a sample program in the C language

### 3.2 Research measures

The authors carry out a questionnaire for students of enrollment-in-school of the Shibaura Institute of Technology department of information engineering to grasp the PM image that students have. Performed a discrimination analysis with these questionnaire results to decide substitute characteristic (personality trait) and an expression of relations to derive the quality that is necessary for PM. After the start of the exercise, apply the substitute characteristic of the person of study to an expression of relations from the questionnaire results, and makes PM candidate, the student who judged that a distinction result turns to PM. Next by increasing the knowledge degree of skill and the software engineering of the JAVA of the person of study, arrived at expression of relations to calculate analysis/design in charge, coding in charge, role in charge of QA by a second factor hypothesis model of the SEM which added improvement to the hypothesis model of Shirakawa, et al.[1]. Apply this expression of relations to EtUDE/GO after appropriate time. By this, generate the most suitable plan of the team formation automatically. After that, students suitable for each role are chosen by automatically created team formation and confirm that is the team formation without the capability difference between each team. Perform exercise class based on this and half year after the end of exercise, use exercise results and the questionnaire results of the persons of study

and evaluate the team formation method that considered a PM type. As a result, in the team formation of the students without the exercise experience, high team formation of the cooperativeness between members is realizable by considering a PM type. (Fig. 2)

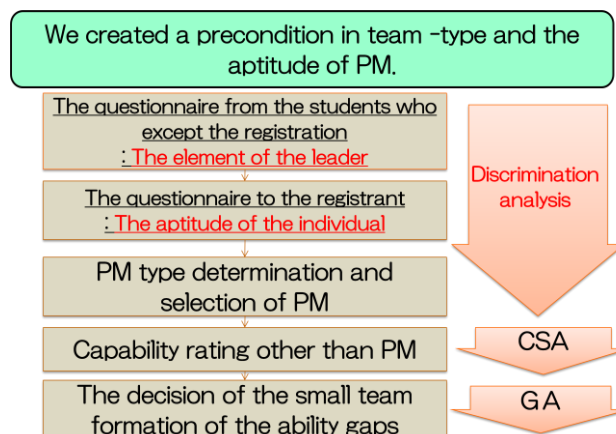


Fig. 2 The verification method for evaluations

## 4. Analysis method

### 4.1 PM candidate's selection method

PM as for project team "concentrate on means to achieve targets" and demand the answer to "can targets be achieved?" On the other hand, the leader "defines results to be expected" and finds the answer to "what we want to achieve?"[28] PM by this exercise can be referred to as close to the role of the leader instead of the business capability currently searched for in the actual world. Enforcement of the prior questionnaire for PM candidate selection was done for 207 students of 1st and 2nd grade of this school who understand the leader's concepts. In addition, used the expression by the questionnaire as "a leader" and not "PM" because the targeted persons did not have a concept of PM. PM which the persons of study evaluate, and the alternative characteristic (character data) actually acquired from the study persons are considered based













Table 7 Calculation of the genetic conformity degree

P1	<p>The calculation of the role performance capability in the individual (Expression 4)</p> $y_{il} = \sum_{j=1}^p \alpha_{ij} x_{jl} + c_i \quad \dots(4)$ <p><i>i</i>: Role performance capability number,  <i>j</i>: Subject number  <i>y<sub>il</sub></i>: Students' role performance capability ,  <i>α<sub>il</sub></i>: Coefficients of role performance capability  <i>x<sub>il</sub></i>: Students' score, <i>C<sub>i</sub></i>: Constants</p>
P2	<p>Number of Team Members: 4 to 5 students                  The arrangement of the student above the average (0) of each role performance ability ( The procedure of the arrangement follows the choice of GA, intersecting, a mutation ).</p>
P3	<p>A calculation of the mean capability (Expression 5)</p> $O_k = \frac{1}{n_k \gamma} \sum_{k=1}^{n_k} \sum_{i=1}^{\gamma} w_i y_{il} \quad \dots(5)$ <p><i>O<sub>k</sub></i>: Capability of team <i>k</i> (Average),  <i>W<sub>i</sub></i>: Importance of role performance capability <i>i</i> in team <i>k</i>,  <i>y<sub>il</sub></i>: Ability of role performance capability in student <i>l</i>,  <i>n<sub>k</sub></i>: Number of Students in team <i>k</i>,  <i>γ</i>: Number of role performance capability</p>
P4	<p>A calculation of the variance value among teams :                  Preservation of the team formation of the smallest variance (Expression 6)</p> $O = \min \left[ \frac{1}{m} \sum_{k=1}^m (O_k - \bar{O})^2 \right] \dots(6)$ <p><i>o</i>: The objective-function, <math>\bar{O}</math>: The mean of the capability of all the teams, <i>k</i>:Team <i>k</i>, <i>m</i>: Number of teams</p>
P5	<p>The parameter of GA: The number of repetition                  The computation repeats a procedure from P2 to P4.</p>

The result of this team formation is an exercise summary as in Table 8.

Although there were students who were absent during the study registration, since judgment of whether to abandon one's rights to an exercise did not stick, it assigned having assumed that they participated in the exercise study, and were considered as the candidates. However, one exercise absentee appeared from persons with role.

Although one person did team formation exercise registration among 45 exercise schedule persons, since he abandoned immediately after team formation, 1 team of three persons was made.

Table 8 Outlines of an exercise, 2008 fiscal year

Exercise Task	Development of the bookselling system
Exercise Term	September 18th, 2008 to January 15th, 2009
Number of Objective Students	44 students
Number of Team Members	3 to 5 students
Number of Teams	11 teams

### 6.2 Equability evaluation of the team formation by an analysis of variance

Evaluation of analysis of variance, which verifies the equability about four roles, PM, analysis/design, coding, and QA, using an analysis of variance is done.

Table 9 Analysis of variance (Single factor) Results

Team No.1~6

Source of Variance	SS	df	MS	F	P-value	F cnt
Between Groups	0.148	5	0.030	0.003	1.000	2.773
Within Groups	194.848	18	10.825			
Total	194.996	23				

Team No.7 ~11

Source of Variance	SS	df	MS	F	P-value	F cnt
Between Groups	1.099	4	0.275	0.030	0.998	3.056
Within Groups	138.419	15	9.228			
Total	139.518	19				

As for the evaluation of the analysis of variance (Single factor), P the probability of the critical region which value < experimenter sets up, and F boundary value < the observed variance ratio of "rejecting a null hypothesis" and the probability of a critical region is 5%.

## 7 Validity evaluation of the team formation optimization after the end of the exercise

### 7.1 Method of judgment

The instructors containing TA evaluated the contribution to the subject achievement in all exercise lessons participants' teams after the end of the exercise based on the presentation of middle and the last announcement, and the log information which the last product and EtUDE of the exercise acquired.

Validity evaluation of the team formation classified by PM type is performed by "evaluation of the product according to team", and "the questionnaire result after an exercise."

### 7.2 Validity evaluation of team formation optimization

In this team formation, carried out equalization of capability according to the type of the team. Therefore it was judged that there is the difference of capability between the team type M (Management) and the team type P (Partnership), when seen from the team type point, but evaluation was judged with no gap.

Therefore it was proved that evaluation became equal by considering the type of the team rather than the method to make capability equality simply.

The correlation coefficient of evaluation of the product according to PM type and team capability, the capability numerical value calculated by evaluation of a team and analysis became -0.644. Since role performance capability is taken into consideration in team formation even if the capability of a team is low, it is good evaluation Fig. 8).

Table 10 Results of the Independent Samples T Test Group Statistics

	Team	N	Mean	SD	SE
Capability	M	6	1.350	0.356	0.145
	P	5	-1.600	1.056	0.472
Evaluation	M	6	-0.333	0.983	0.401
	P	5	0.380	0.983	0.440

Independent Samples T Test

Levine's test for equality of variance		F	Sig.
Capability	Equal variance assumed	11.488	0.008
	Equal variance not assumed		
Evaluation	Equal variance assumed	0.285	0.607
	Equal variance not assumed		

t-test for Equality of Means						
t	df	Sig. (2 tailed)	Mean Difference	SD Difference	95% Confidence Interval of the Difference	
					Lower	Upper
6.475	9	0.000	2.950	0.456	1.919	3.981
5.970	4.761	0.002	2.950	0.494	1.660	4.240
-1.198	9	0.261	-0.713	0.595	-2.060	0.634
-1.198	8.642	0.263	-0.713	0.595	-2.069	0.642

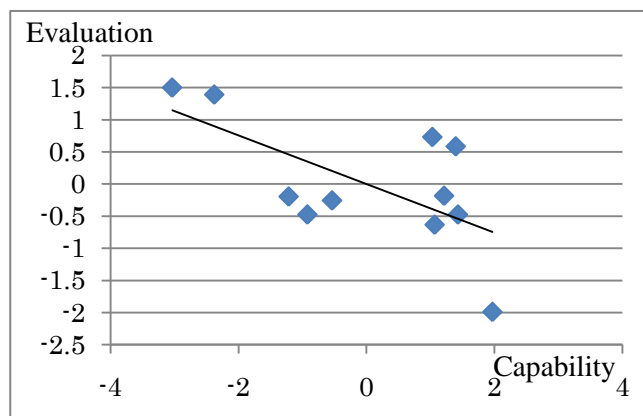


Fig. 8 Product evaluation and team capability

## 8 Conclusion

### 8.1 Result of Research

In order to analyze the human factors, which affect on team formation by a software development exercise worked out a secondary factors hypothetical model, performed the analysis procedure of SEM and inspected SEM hypothetical model. As a result of role

performance capability was able to consider it as the true factor (criterion variables), and was able to demand for the expression of relations between seven alternative characteristics (explanatory variable). Applied those expression of relations to EtUDE/GO, and generated the optimum team formation proposal. Made a team formation based on this proposal, and performed an exercise lesson of students. After an exercise class of a half- year, analyzed the influence that optimization of the team formation brought on exercise class.

According to the type of PM decided position members and performed role allotment and the team formation of the members. As a result, was able to realize team formation with small capability difference between teams, and confirmed was able to achieve exercise problems without one halfway dropout in all teams. Furthermore, by this inspection, the team formation of the students without the exercise experience was able to realize the high team formation of the sense of cooperation of team members respect to each other by considering a PM type. PM allots the work to the team of the management type by result units, and a tendency to be able to leave to each person is in particular strong. But the unevenness was big, and PM confirmed that the team of the partnership type made results for every WBS by cooperating with all the members.

In evaluation comparison of the degree of fullness of the cooperativeness and the exercise in this time and the team of 2006, "it was very substantial" became 31.1% in 2008 from 12.3% in 2006, and "all the members cooperated" became 60.0% in 2008 from 47.4% in 2006.

There was no clear difference in the degree of fullness according to PM type carried out this time, and evaluation of cooperativeness. (Table 11 ).

Table 11 Fullness degree and cooperativeness according to type of PM

	Fullness degree(%)		Cooperativeness (%)	
	Type1	Type2	Type1	Type2
Strongly Agree	25.0	42.1	58.3	68.4
Agree	62.5	52.6	16.7	26.3
Disagree	12.5	0.0	25.0	5.3
Strongly Disagree	0.0	5.3	0.0	0.0
Total	100.0	100.0	100.0	100.0

In addition, in a team "what is necessary to redevelop it with the same members" regardless of team type (M: Management type, P: partnership type), the thing which each demanded from team members of good evaluation and bad members team became the same results Table 12).

Table 12 Things PM demands from team members

What is necessary to redevelop it in the same members?	Team type ( Respondent : PM)	Evaluation
(requirements of PM)	M	1.499
(i)The skill of the requirements analyses	P	1.390
(ii)Clarification of the work allotment	P	0.731
(iii)Schedule management	P	0.585
	M	-0.183
	P	-0.195
	P	-0.256
	M	-0.475
(i)Adhere rigidly to the rules	P	-0.475
(ii)Report of the progress	P	-0.633
(iii)Communication	P	-1.989

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