Statistical Analysis Based on Software Process Monitoring Datafor Effective Project Management

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Abstract- **Software development projects influenced by many human factors often generate risks caused by various software process problems. These risks lead to QCD (Quality, Cost, and Delivery) related problems, such as system failures after release, budget overrun, and delivery delay which may cause the project to fail. Therefore, in order to make a software project successful, it is important to perform process monitoring activities and design quality evaluation ones. In this paper, considering the initial project risks, we conduct statistical analysis by using software process monitoring data obtained by above activities, and discuss the effect of two activities. We also discuss the significant process factors affecting QCD.**

Keywords- Initial Project Risk; Process Monitoring; Design Quality Evaluation; Principal Component Analysis; Multiple Regression Analysis; Discriminant Analysis

I. INTRODUCTION

In recent years, software development project has become more large-scaled, complicated, and diversified. At the same time, customers' requirement of high quality and short delivery has increased. Therefore, in order to lead a software development project to succeed certainly, it is very important for project managers to conduct adequate project management techniques in the software development process. At this time, we need to statistically analyse process data observed in the software development project. Based on the process data; we can establish PDCA (Plan-Do-Check-Act) management cycle to improve the software development process with respect to software management measures about QCD [1], [2].

Generally, software development projects progress through the process of contract, development plan, system design, program design, coding, debugging, test plan, program testing, system testing. Many risks are latent in each development process. It is important to lead to success of projects so that project managers perform adequate management, and reasonably promote risk management for these risks. Therefore, the project managers have to respond to potential risks in each process, and it is important for them to have project management techniques to perform highly quality software development within the scheduled cost and delivery. However, it is not easy for them to perform adequate management in highly complicated and diversified software development projects. Then, continuous improvement of a software development process makes promotion possible by process improvement activities of process monitoring and design quality evaluation. Generally, the process monitoring activities review project management, observe the detection and solution of QCD related problems, and improve the management process to lead a project to success (see Fig. 1). Further, design quality evaluation activities quantify the completeness of requirement and design specifications, and improve the software development process to eliminate software faults.

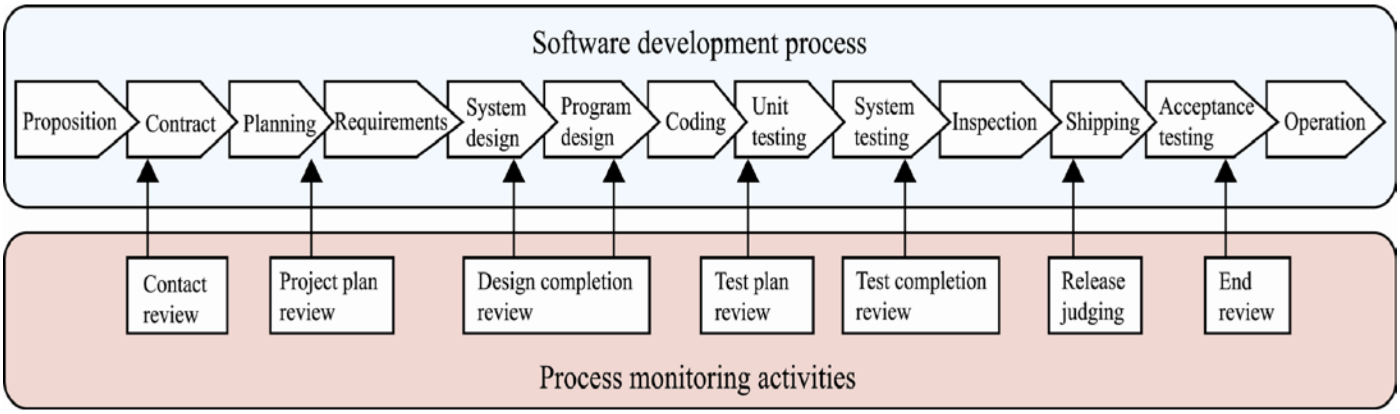

Fig. 1 Overviews of process monitoring activities

In this paper, based on the results of Fukushima et al. [3] and Kasuga et al. [4], we analyze actual software process monitoring data with initial project risks by using multivariate linear analyses, i.e., principal component analysis, multiple regression analysis, and discriminant analysis. At the same time, we clarify the software process factors affecting QCD management measures. Furthermore, we quantitatively analyze the effect of the process improvement by process monitoring and design quality evaluation.

II. ANALYSIS OF THE EFFECT OF DESIGN QUALITY EVALUATION ACTIVITIES

A. Data Used for Analysis

We analyse the effect of design quality evaluation activities by using actual measurement data of projects (as shown in Table I). In order to consider initial project risks, the actual process monitoring data of projects are normalized by the development size (KLOC, 10^3 lines of code) in this paper.

Explanatory and objective variables introduced in this paper are explained in the following.

X_1: The risk ratio of project initiation. The risk ratio is given by

$$\text{Risk ratio} = \sum_i \{\text{risk item}(i) \times \text{weight}(i)\}, \qquad (1)$$

where the risk estimation checklist has weight(i) in each risk item(i), and the risk ratio ranges between 0 and 100 points. Project risks are identified by interviewing using the risk estimation checklist [3]. From the identified risks, the risk ratio of project initiation is calculated by Eq. (1).

X_2: The number of contract problems per development size. This variable is a calculated number of problems which were detected during contract review. The problems are weighted depending on the scale of the problem:

Weighted problems = (the number of major problems) + (the number of mid-size problems) × 0.5 + (the number of minor problems) × 0.1.

X_3: The number of days of measures per development size. This variable is the total number of days how long it took for the problems detected during contract review to be solved.

X_4: The number of plan problems per development size. This variable is a calculated number of problems which were detected during project planning review.

X_5: The number of days of measures per development size. This variable is the total number of days how long it took for the problems detected during project planning review to be solved.

X_6: Design quality evaluation implementation as a stratification factor (1 = evaluation, 0 = no evaluation).

Y_q: The number of faults as a management measure of quality.

The number of faults = (the number of faults found during acceptance testing) + (the number of faults in production).

Y_c: The cost excess ratio as a management measure of cost.

The cost excess ratio = (actual cost) / (budget).

If the cost excess ratio is over 1.0, it means that the cost exceeded the software development budget.

Y_d: The delivery delay ratio as a management measure of delivery.

The delivery delay ratio = (actual development period) / (scheduled development period).

If the delivery delay ratio is over 1.0, it means that the period exceeded the scheduled software development period.

TABLE I PROCESS MONITORING DATA

Project No.	Initial project risks	Process monitoring				Design evaluation	QCD management indices		
	Risk ratio X_1 (0~100)	Number of contract problems per developmentsize X_2 (cases/KLOC)	Number of days of measures per developmentsize (Contract problems) X_3 (days/KLOC)	Number of plan problems per developmentsize X_4 (cases/KLOC)	Number of days of measures per developmentsize (Plan problems) X_5 (days/KLOC)	X_6 (1=evaluation)	Number of faults Y_q (cases)	Cost excess ratio Y_c (1<overrun)	Delivery delay ratio Y_d (1<overrun)
1	19	0.3226	8.0645	0.4731	10.4301	0	1	1.02	1.04
2	13	0.6897	4.4828	0.2586	2.4138	0	0	1.02	1.04
3	11	0.1271	4.3220	0.0593	1.1864	0	2	0.95	1.00
4	24	0.1504	3.0827	0.2932	11.8797	0	5	1.00	1.00
5	17	0.1306	1.3433	0.0821	4.5522	0	0	1.00	0.94
6	29	0.6383	2.5532	0.9787	40.0000	0	1	1.03	1.08
7	35	0.2410	5.0602	0.4940	19.3976	0	4	1.08	1.04
8	25	0.0761	0.1384	0.0692	0.5190	0	0	0.89	1.00
9	28	0.0573	0.5725	0.0458	0.5725	0	3	1.08	1.05
10	38	0.3226	2.1774	0.2581	3.2258	0	5	1.10	1.05
11	42	0.3285	2.3358	0.2920	3.7226	0	6	1.14	1.05
12	30	0.2564	1.9231	0.3205	3.2051	0	3	1.08	1.05
13	28	0.1493	1.9403	0.2239	2.9851	0	2	1.00	1.00
14	35	1.2500	7.5000	1.5625	62.5000	0	0	1.10	1.22
15	23	0.3309	7.8676	0.1838	7.6471	1	0	0.97	1.06
16	29	0.3448	10.3448	0.3793	14.4828	1	0	0.89	1.00
17	25	0.0467	2.6168	0.0047	0.0935	1	0	0.99	1.00
18	18	0.0000	0.0000	1.1667	10.0000	1	0	0.78	0.99
19	30	0.0588	0.1176	0.1882	0.9412	1	0	0.92	1.00

B. Principal Component Analysis

In order to clarify the relationship among variables and analyze the effect of design quality evaluation activities on QCD management measures, principal component analysis is performed by using the normalized data in Table I. It is found that the precision of analysis is high from Table II. And the factor loading values are obtained as shown in Table III. The principal component scores are obtained as shown in Table IV. From Table III, let us newly define the first and second principal components as follows.

- The first principal component is defined as the measure for the cost and delivery related factor.
- The second principal component is defined as the measure for the quality and cost related factor.

TABLE II SUMMARY OF EIGENVALUES AND PRINCIPAL COMPONENTS

Component	Eigenvalue	Contribution ratio	Cumulative contribution ratio
1	3.930	0.437	0.437
2	2.406	0.267	0.704

TABLE III FACTOR LOADING VALUES

	Component 1	Component 2
X_1	0.488	0.496
X_2	0.912	-0.207
X_3	0.450	-0.387
X_4	0.731	-0.418
X_5	0.884	-0.319
X_6	-0.349	-0.630
Y_q	0.121	0.884
Y_c	0.577	0.715
Y_d	0.933	-0.033

TABLE IV PRINCIPAL COMPONENT SCORES

	Component1	Component2
1	0.230	-0.382
2	0.064	-0.468
3	-0.770	-0.120
4	-0.218	0.779
5	-0.932	-0.027
6	1.252	-0.367
7	0.575	0.854
8	-0.891	-0.089
9	-0.286	1.136
10	0.328	1.537
11	0.502	1.920
12	0.111	0.919
13	-0.405	0.508
14	3.279	-1.069
15	-0.089	-1.058
16	-0.093	-1.436
17	-0.887	-0.427
18	-0.852	-1.719
19	-0.917	-0.490

1. Factor Loading Values

Fig. 2 is a scatter plot of the factor loading values (see Table III). From Fig. 2, we can consider the correlation as follows.

- Risk ratio (X_1) has shown positive correlation to QCD management measures.
- Design quality evaluation activities (X_6) have shown negative correlation to QCD management measures.

Therefore, we conclude that initial project risks and design quality evaluation activities have an important impact on QCD management measures.

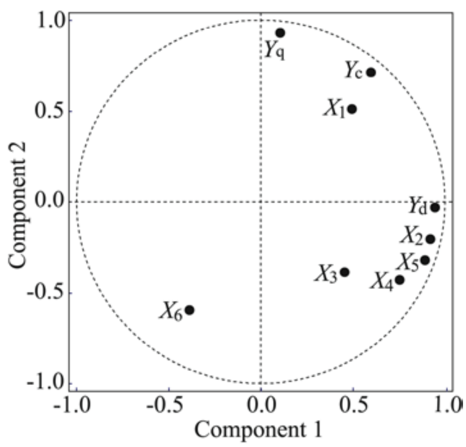

Fig. 2 Scatter plot of the factor loading values

2. Principal Component Scores

Fig. 3 is a scatter plot of the principal component scores (see Table IV). Projects in which design quality evaluation activities were carried out are indicated by the "●"marks, whereas "○"marks indicate that design quality was not evaluated. It can be found in Fig. 3 that projects, in which design quality evaluation activities were carried out, can keep the number of faults, the cost excess ratio, and the delivery delay ratio low because the values of the first and second principal components are small.

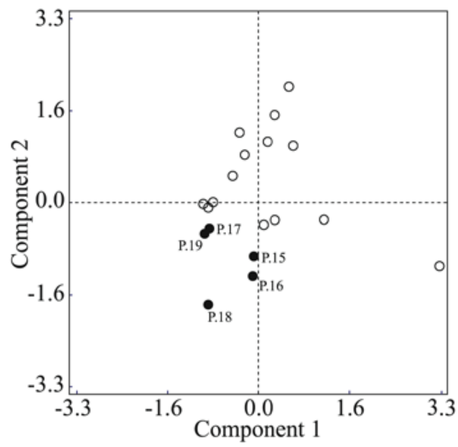

Fig. 3 Scatter plot of the principal component scores

III. FACTOR ANALYSIS AFFECTING THE NUMBER OF FAULTS, THE COST EXCESS RATIO, AND THE DELIVERY DELAY RATIO

A. Correlation Analysiss

By using the normalized data in Table I, the result of correlation analysis is shown in Table V. From Table V, we can consider the correlations as follows.

- Y_q has shown strong correlation to X_1 and X_6.
- Y_c has shown strong correlation to X_1 and X_6.
- Y_d has shown strong correlation to X_1, X_2, X_4, and X_5.
- X_2 has shown strong correlation to X_3 and X_4.
- X_2 and X_4 have shown strongish correlation to X_5.

TABLE V CORRELATION MATRIX

	X_1	X_2	X_3	X_4	X_5	X_6	Y_q	Y_c	Y_d
X_1	1								
X_2	0.226	1							
X_3	-0.029	0.516	1						
X_4	0.198	0.659	0.224	1					
X_5	0.291	0.815	0.409	0.861	1				
X_6	-0.094	-0.276	0.140	-0.002	-0.151	1			
Y_q	0.530	-0.140	-0.185	-0.179	-0.156	-0.503	1		
Y_c	0.552	0.434	0.092	-0.014	0.228	-0.635	0.613	1	
Y_d	0.449	0.855	0.380	0.656	0.777	-0.241	0.049	0.534	1

B. Multiple Regression Analysis (Number of Faults)

In order to select variables for constructing a precise equation, we conduct the all possible regression analysis.

Based on the possible regression and the correlation analyses, X_1, X_2, and X_6 are selected as important factors for predicting the number of software faults.

A multiple regression analysis is applied to the measurement data of the projects as shown in Table I. Then, using X_1, X_2, and X_6, we obtain the estimated multiple regression equation for predicting the number of software faults, Y_q, given by Eq. (2) as well as the normalized multiple regression expression of Eq. (2), Y_q^N, given by Eq. (3):

$$Y_q = 0.143 \cdot X_1 - 2.935 \cdot X_2 - 2.576 \cdot X_6 - 0.540, \quad (2)$$

$$Y_q^N = 0.573 \cdot X_1 - 0.426 \cdot X_2 - 0.567 \cdot X_6. \quad (3)$$

In order to check the goodness-of-fit adequacy of our model, the coefficient of multiple determination (R^2) is calculated as 0.648. Furthermore, the squared multiple correlation coefficients, called the contribution ratio, adjusted for degrees of freedom (adjusted R^2) is given by 0.578, and the derived Eq. (2) is significant at 1% level. The result of multiple regression analysis is summarized in Tables VI and VII.

From Table VI, it is found that the accuracy of these multiple regression equations is high. Then, we can predict the number of software faults by using Eq. (2). From Eq. (3), the order of the degree affecting the objective variable Y_q is $X_2 < X_6 < X_1$. Therefore, we conclude that the risk ratio, the design quality evaluation activities, and the number of contract problems have an important impact on the number of software faults.

TABLE VI TABLE OF ANALYSIS OF VARIANCE (Y_q)

Source of variation	DF	SSq	MSq	F-value
Due to regression	3	49.321	16.440	9.207**
Error	15	26.784	1.786	
Total	18	76.105		

TABLE VII ESTIMATED PARAMETERS (Y_q)

Factor	Coefficient	SE	t-value	Standard coefficient
Intercept	-0.540	1.098	-0.491	
X_1	0.143	0.039	3.640	0.573
X_2	-2.935	1.123	-2.613	-0.426
X_6	-2.576	0.725	-3.554	-0.567

C. Multiple Regression Analysis (Cost Excess Ratio)

In order to select variables for constructing a precise equation, we conduct the all possible regression analysis.

Based on the possible regression and the correlation analyses, X_1, X_2, X_4, and X_6 are selected as important factors for predicting the cost excess ratio.

A multiple regression analysis is applied to the measurement data of the projects as shown in Table I. Then, using X_1, X_2, X_4, and X_6, we obtain the estimated multiple regression equation for predicting the cost excess ratio, Y_c, given by Eq. (4) as well as the normalized multiple regression expression of Eq. (4), Y_c^N, given by Eq. (5).

$$Y_C = 0.005 \cdot X_1 + 0.143 \cdot X_2 - 0.092 \cdot X_4 - 0.090 \cdot X_6 + 0.882, \quad (4)$$

$$Y_C^N = 0.485 \cdot X_1 + 0.479 \cdot X_2 - 0.426 \cdot X_4 - 0.458 \cdot X_6. \quad (5)$$

In order to check the goodness-of-fit adequacy of our model, the coefficient of multiple determination (R^2) is calculated as 0.772. Furthermore, the squared multiple correlation coefficients, called the contribution ratio, adjusted for degrees of freedom (adjusted R^2) is given by 0.706, and the derived Eq. (4) is significant at 1% level. The result of multiple regression analysis is summarized in Tables VIII and IX.

From Table VIII, it is found that the accuracy of these multiple regression equations is high. Then, we can predict the cost excess ratio by using Eq. (4). From Eq. (5), the order of the degree affecting the objective variable Y_c is $X_4 < X_6 < X_2 < X_1$. Therefore, we conclude that the risk ratio, the number of contract problems, the design quality evaluation activities, and the number of plan problems have an important impact on the cost excess ratio.

TABLE VIII TABLE OF ANALYSIS OF VARIANCE (Y_c)

Source of variation	DF	SSq	MSq	F-value
Due to regression	4	0.110	0.028	11.817**
Error	14	0.033	0.002	
Total	18	0.143		

TABLE IX ESTIMATED PARAMETERS (Y_c)

Factor	Coefficient	SE	t-value	Standard coefficient
Intercept	0.882	0.040	22.217	
X_1	0.005	0.001	3.683	0.485
X_2	0.143	0.055	2.610	0.479
X_4	-0.092	0.038	-2.423	-0.426
X_6	-0.090	0.027	-3.330	-0.458

D. Multiple Regression Analysis (Delivery Delay Ratio)

In order to select variables for constructing a precise equation, we conduct the all possible regression analysis.

Based on the possible regression and the correlation analyses, X_1 and X_2 are selected as important factors for predicting the delivery delay ratio.

A multiple regression analysis is applied to the measurement data of the projects as shown in Table I. Then, using X_1 and X_2, we obtain the estimated multiple regression equation for predicting the delivery delay ratio, Y_d, given by Eq. (6) as well as the normalized multiple regression expression of Eq. (6), Y_d^N, given by Eq. (7):

$$Y_d = 0.002 \cdot X_1 + 0.150 \cdot X_2 + 0.940, \quad (6)$$

$$Y_d^N = 0.270 \cdot X_1 + 0.794 \cdot X_2. \quad (7)$$

In order to check the goodness-of-fit adequacy of our model, the coefficient of multiple determination (R^2) is calculated as 0.801. Furthermore, the squared multiple correlation coefficients, called the contribution ratio, adjusted for degrees of freedom (adjusted R^2) is given by 0.776, and the derived Eq. (6) is significant at 1% level. The result of multiple regression analysis is summarized in Tables X and XI.

From Table X, it is found that the accuracy of these multiple regression equations is high. Then, we can predict the delivery delay ratio by using Eq. (6). From Eq. (7), the order of the degree affecting the objective variable Y_d is $X_1 < X_2$. Therefore, we conclude that the number of contract problems and the risk ratio have an important impact on the delivery delay ratio.

TABLE X TABLE OF ANALYSIS OF VARIANCE (Y_d)

Source of variation	DF	SSq	MSq	F-value
Due to regression	2	0.046	0.023	32.124**
Error	16	0.011	0.001	
Total	18	0.057		

TABLE XI ESTIMATED PARAMETERS (Y_d)

Factor	Coefficient	SE	t-value	Standard coefficient
Intercept	0.940	0.021	44.630	
X_1	0.002	0.001	2.355	0.270
X_2	0.150	0.022	6.932	0.794

IV. ANALYSIS OF IMPROVEMENT EFFECT OF SOFTWARE DEVELOPMENT PROCESS

In order to analyse the improvement effect of software development process, discriminant analysis is performed by using the normalized data in Table I. Based on the same selected explanatory variables as the multiple regression analysis. The response variables for discriminant analysis, $Z(Y_q)$, $Z(Y_c)$, and $Z(Y_d)$, are defined as follows.

- $Z(Y_q)$=0: The software development project will not have any software faults. (Y_q=0)
- $Z(Y_q)$=1: The software development project will have some software faults. ($Y_q \geq 1$)
- $Z(Y_c)$=0: The actual cost of software development project will not exceed the software development budget.($Y_c \leq 1.00$)
- $Z(Y_c)$=1: The actual cost of software development project will exceed the software development budget. ($Y_c \geq 1.01$)
- $Z(Y_d)$=0: The actual period of software development project will not exceed the scheduled software development period. ($Y_d \leq 1.00$)
- $Z(Y_d)$=1: The actual period of software development project will exceed the scheduled software development period. ($Y_d \geq 1.01$)

A discriminant analysis is applied to the normalized data and the above response variables. Then, we obtain the estimated discriminant equations given by Eqs. (8), (9), and (10).

$$Z(Y_q) = -0.156 \cdot X_1 + 5.414 \cdot X_2 + 6.699 \cdot X_6 + 0.637, \quad (8)$$

$$Z(Y_c) = -0.160 \cdot X_1 - 4.587 \cdot X_2 - 0.475 \cdot X_4 + 4.289 \cdot X_6 + 4.715, \quad (9)$$

$$Z(Y_d) = -0.099 \cdot X_1 - 4.919 \cdot X_2 + 3.972. \quad (10)$$

If the discrimination score in Eqs. (8), (9), and (10) is more than 0, the response variable is 0, otherwise 1. The predicted response variables in Eqs. (8), (9), and (10) and actual measurement values are shown in Tables XII, XIII, and XIV where we apply actual measurement data in all 19 projects to the discriminated variables. In order to check the goodness-of-fit adequacy of our model, the discriminant hitting ratio is calculated as shown in Table XV from Tables XII, XIII, and XIV. From Table XV, it is found that the accuracy of these discriminant equations is high.

TABLE XII GENERAL JUDGMENT (Y_q)

Project No.	Actual	Predicted	Score Z	D_A^2	D_B^2
1	1	1	-0.582	3.004	1.841
2	0	0	2.342	4.861	9.545
3	1	1	-0.391	5.512	4.729
4	1	1	-2.295	4.933	0.344
5	0	1	-1.309	4.608	1.989
6	1	1	-0.433	3.015	2.148
7	1	1	-3.521	7.860	0.817
8	0	1	-2.853	6.195	0.489
9	1	1	-3.423	7.452	0.606
10	1	1	-3.548	8.549	1.454
11	1	1	-4.140	11.253	2.973
12	1	1	-2.657	5.361	0.047
13	1	1	-2.925	6.024	0.174
14	0	0	1.942	9.640	13.524
15	0	0	5.538	2.186	13.263
16	0	0	4.677	2.060	11.414
17	0	0	3.688	1.697	9.072
18	0	0	4.527	2.339	11.393
19	0	0	2.973	2.282	8.227

TABLE XIII GENERAL JUDGEMENT (Y_c)

Project No.	Actual	Predicted	Score Z	D_A^2	D_B^2
1	1	1	-0.028	2.566	2.509
2	1	1	-0.651	9.213	7.912
3	0	0	2.345	3.523	8.212
4	0	0	0.047	2.018	2.113
5	0	0	1.358	2.021	4.737
6	1	1	-3.317	8.013	1.380
7	1	1	-2.223	5.878	1.431
8	0	0	0.334	2.033	2.702
9	1	1	-0.048	2.659	2.563
10	1	1	-2.965	7.594	1.663
11	1	1	-3.648	10.305	3.009
12	1	1	-1.412	3.426	0.602
13	0	1	-0.555	2.600	1.491
14	1	1	-7.360	25.566	10.846
15	0	0	3.720	3.591	11.031
16	0	0	2.604	2.917	8.124
17	0	0	4.789	2.680	12.258
18	0	0	5.571	12.286	23.427
19	0	0	3.846	2.416	10.108

TABLE XIV GENERAL JUDGMENT (Y_d)

Project No.	Actual	Predicted	Score Z	D_A^2	D_B^2
1	1	0	0.504	0.901	1.909
2	1	1	-0.708	6.696	5.280
3	0	0	2.258	2.357	6.872
4	0	0	0.856	0.030	1.741
5	0	0	1.646	0.591	3.884
6	1	1	-2.040	4.662	0.583
7	1	1	-0.679	2.557	1.199
8	0	0	1.122	0.097	2.341
9	1	0	0.918	0.475	2.310
10	1	1	-1.378	4.263	1.508
11	1	1	-1.803	6.511	2.905
12	1	1	-0.260	1.071	0.552
13	0	0	0.465	0.420	1.350
14	1	1	-5.643	21.750	10.464
15	1	0	0.067	0.680	0.814
16	0	1	-0.596	1.342	0.151
17	0	0	1.267	0.151	2.685
18	0	0	2.190	0.623	5.002
19	0	0	0.712	0.866	2.290

TABLE XV DISCRIMINANT HITTING RATIO

	True	False	Discriminant hitting ratio(%)
Y_q	17	2	89.47
Y_c	18	1	94.74
Y_d	15	4	78.95

So, in order to evaluate the improvement effect of software development process, we analyze 14 projects (Project No.1-14) in which design quality evaluation activities were not carried out by using these discriminant equations. Then, we assume that projects (Project No.1-14) were carried out the design quality evaluation activities (X_6=1). However, we do not analyze the improvement effect of software development process for delivery because X_6 is not selected in Eq. (10).

The predicted response variables and discrimination scores are calculated as shown in Tables XVI and XVII by using Eqs. (8) and (9). From Tables XVI and XVII, most predicted response variables (other than cost of Project No.14) indicate 0. Therefore, we conclude that quality and cost management measures are improved by carrying out the design quality evaluation activities.

TABLE XVI RESULT OF DISCRIMINANT (Y_q)

Project No.	Predicted	Score Z
1	0	6.117
2	0	9.041
3	0	6.308
4	0	4.404
5	0	5.390
6	0	6.266
7	0	3.178
8	0	3.846
9	0	3.276
10	0	3.151
11	0	2.559
12	0	4.042
13	0	3.774
14	0	8.641

TABLE XVII RESULT OF DISCRIMINANT (Y_c)

Project No.	Predicted	Score Z
1	0	4.261
2	0	3.638
3	0	6.634
4	0	4.336
5	0	5.647
6	0	0.972
7	0	2.066
8	0	4.623
9	0	4.241
10	0	1.324
11	0	0.641
12	0	2.877
13	0	3.734
14	1	-3.071

V. CONCLUSIONS

In this paper, we have quantitatively analyzed the effect of the software development process improvement by applying the methods of multivariate linear analyses to actual measurement data.

As a result of principal analysis, we have found that cost and delivery are related to the risk ratio (initial project risks) and the process monitoring activities, quality and cost related to the risk ratio (initial project risks) and the design quality evaluation activities. Furthermore, the design quality evaluation activities have a beneficial effect for improving QCD management measures because projects, in which the design quality evaluation activities were performed, have the good values of QCD management measures.

As a result of multiple regression analyses, we have found that the risk ratio (initial project risks) and the number of problems which was detected during contract review have an impact on software management measures about quality, cost, and delivery (QCD). Therefore, in order to lead a project to successful conclusion, it is important to conduct risk management, i.e., the understanding of risks, the identification of risks, and the early reduction of risks. Also it is important to use project management techniques as typified by process monitoring activities, to adequately conduct the contract review, and to early improve QCD related problems.

As a result of discriminant analysis, the design quality evaluation activities have a beneficial effect for improving QC management measures because most QC management measures of projects in which design quality evaluation activities were not carried out are improved.

Based on the result of statistical analysis above, in order to lead a software development project to success, it is important to continually improve the software development process by conducting process monitoring activities and design quality evaluation activities.

In the future, we continually need to improve the software development process by gathering more detailed and quantitative data of software development projects, statistically analyzing the data, and quantitatively evaluating the results of analyses.

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