Research on Quality Measuring of CMMI Cyclic Implementation in Software Process

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Abstract—**Based on the specific elements in terms of process area, project, practice and relevant methodologies, which were adopted from Capability Maturity Model Integration(CMMI), this paper studied feasible appraisal program that combined the CMMI implementation cycle model into entire software process, therefore, the index system and measurement model in measuring the quality of software developing process were built and the barrier of CMMI model could only be used in enterprise CMMI certification was broken down.**

Index Terms—**CMMI, Software Process, Quality**

I. Introduction

Along with the in-depth development of applying information technology, and growing importance of software and process quality, how to assess software quality and how to reinforce the quality management in the process of software development have been put much wide and more concerns. There are two modes of studies in software quality assessment, which mainly are separated into product-oriented and process-oriented. In the process-oriented aspect, Capability Maturity Model (CMM)[1] has been concerned as a significant referencing model in improving developing processes by software developing organizations. Based on CMM, in order to reduce the inconsistency and repetition, cut down the cost of modeling improvement, Capability Maturity Model Integration (CMMI)[2] has been formed. Meanwhile, International Organization for Standardization issued the ISO9000[3] International Standard for Quality Assurance, which provided relatively unified and standardized norm in terms of designing, implementing and improving quality management system. However, no matter whether it concerns CMM, CMMI or ISO9000, from the target perspective, all of them assess the abilities of enterprises or software developing organizations, and focus on designing unified objective and process of assessment in practice.

The object of CMMI appraising is the ability of designing and developing software owned by software developing organizations, is not the software or software project itself. Thus, the specific method that used in collecting and analyzing data in implementing software process measurement is not defined. Due to the reasons of long time framework in implementation and high cost etc., the enterprises, which have acquired the CMMI certification, are reluctant to consistently adopt the methods of CMMI to monitor and improve software processing quality. By doing so, the differences of quality management implemented by enterprises still exist in different software projects. Therefore, from software quality management perspective, implementing assessment system in entire processing circle should be necessary and effective, whether it is for different software projects, or different stages of project, laying the foundation on CMMI leads to design low cost and high efficient method of quality assessment in software processing.

Focusing on the application of CMMI, a number of scholars have made great efforts on its research and study. Documents[4-9] which are based on CMMI, innovate and create some new models and methods. Some of them focus on quantitative methods of risk analysis for software, or emphatically demonstrate the methods of data collecting and analyzing in appraising model, the others are below to performance models which are combined with life-cycle concept or based on GQM method to create software process. Apart from the other major software projects in which the qualitative methods are adopted to implement risk management, document 4 demonstrate a quantitative method in regarding this issue.Whereas, documents [10-13] mostly integrate CMMI model with ISO9000

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to make research on finding more effective software quality control methods. Unfortunately, they all inadequately concern the costs and difficulties of implementing CMMI by enterprises especially by Chinese small software companies.

Document 14 study the key processes of CMMI in five dimensions, in terms of needs development, needs management, system design, design implementation and project monitoring, provide a standardized process which is focused on software process improvement of SF Company. In document 15, Qiu Wanqin combine with GQIM method, address a CMMI based software bug measurement; Wu Zhenyu design framework of software processing automatic management in document 16, and based on it, measurement is introduced into every process area, meanwhile, data collecting and analyzing system has been defined. Document 17 focuses on the CMMI implementation in bank software development center, with combination of considering construction of CMMI standardized process, implementation of process, quality insurance of process and SCAMPI appraising, a rational program has been designed.

Presently, the majority of China enterprises that have been involved in appraisal of CMMI can be certified at maturity level 2 (Managed), while only a few of them could be certified at maturity level 3 (defined) or above. Consequently, this paper starts from level-2 (Managed) of CMMI, according to the specific elements in terms of key process area(KPA), goal and its practice, the relevant quantitative assessment model has been designed and the assessment approaches have been simplified. Thus, it will provide support for software design enterprises to adopt CMMI assessing software in entire processing circle, and to reduce cost of assessment. It is expected that this paper will provide some views on application of CMMI and quality assessment of software processing.

II. Construction of Measurement Index System

A. *The Structure analysis of CMMI*

There are two different kinds of representations. The first is continuous representation, which is utilized in measuring project capability of an enterprise. For its limitation on contents used in continuous capability appraisal, thus, it only represent that enterprise has achieve certain level of implementing capacity in specific project. While, the second representing method is periodic method, it is applied in measuring the maturity of enterprise, i.e. the comprehensive capacity of enterprise software development. Based on periodic method, the contents of appraisal are randomly selected by experts from any project or even any stage of any project, thus, comparing with continuous capability appraisal method, it is more objective and comprehensive, however, they are similar in the nature. This essay mainly study on the basis of continuous representation of CMMI.

This paper mainly focuses on CMMI managed level to design measurement index system and to provide more feasible and effective assessing method for a large number of software developing enterprises at level 2 or below. CMMI include 5 Maturity levels, 22 key process areas. The details are shown in the Table I. Besides, the latest CMMI model recruits Integrated Teaming, Organizational Environment for Integration and Integrated Suppliers Management process areas, however, this 3 process areas target large software enterprises and software enterprises need managing large amount of suppliers, and those needs are not apply in small and middle sized software enterprises. Thus, this essay will not refer to those three process areas.

TABLE I.
MATURITY LEVELS

Maturity level	Key Process Area
5 Optimizing	OID: Organizational Innovation and Deployment
	CAR: Causal Analysis and Resolution
4 Quantitatively Managed	OPP: Organizational Process Performance
	QPM: Quantitative Project Management
3 Defined	RD: Requirements Development
	TS: Technical Solution
	PI: Project Integration
	Ver: Verification
	Val: Validation
	OPF: Organizational Process Focus
	OPD: Organizational Process Definition
	OT: Organizational Training
	IPM: Integrated Project Management
	RskM: Risk Management
	DAR:Decision Analysis and Resolution
2 Managed	ReqM: Requirements Management
	PP: Project Planning
	PMC: Project Monitoring and Control
	SAM: Supplier Agreement Management
	MA: Measurement and Analysis
	PPQA: Process and Product Quality Assurance
	CM: Configuration Management
1 Initial	

Maturity levels advance gradually in due order, if need to achieve certain maturity level, take CMMI level 3 for instance, in addition to satisfy the total 11 process areas of CMMI level 3, the 7 process areas of level 2 should also be satisfied, and so on.

Every process area includes some specific goals and generic goals, systematically, every specific goal contains several specific practices and, every generic goal similarly involves several generic practices. The interrelationship among those process areas, goals and practices are shown in Figure 1.

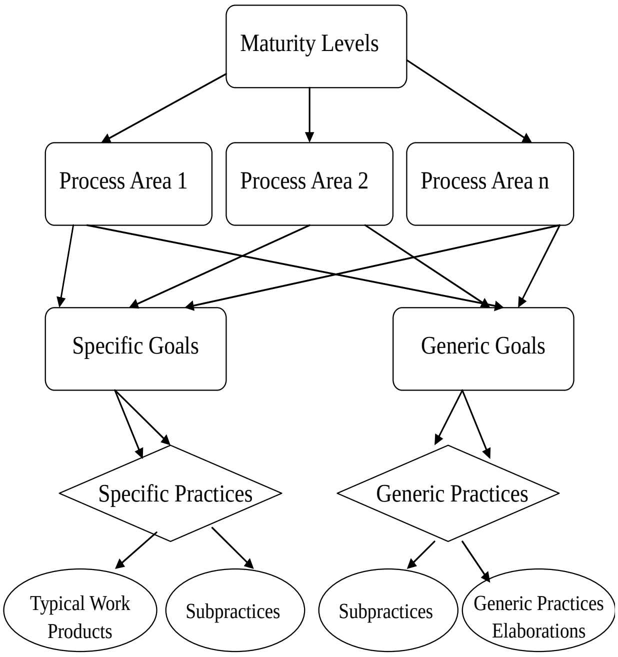

Figure 1. CMMI Structure Diagram

From the diagram above, to evaluate the maturity of software enterprises, all the process areas of relevant level and bellow need to be assessed, so that to evaluate which level that the enterprise has achieved, ultimately the detail operation (to be more specific, typical work products and sub-operations etc.) has been assessed whether the needs have been satisfied.

The index system of measuring software process quality, which is described in this paper, is mainly focus on the specific goals and generic goals in maturity level 2. The appraisal indexes are selected properly from goals within this level and determine weight of every index is the priority in creating quantitative appraisal model.

Within the second level (managed level) of CMMI, 7 key process areas, 15 specific goals and 1 generic goal are involved[18].

Those who need a specification is, every process area include a generic goal, however, this essay set the amount of generic goal as 1, which is due to the reason that generic goal essentially is the priority before achieve several specific goals, therefore, the generic goals in different processes are substantially the same. The detailed relationship of key process areas and goal items in managed levels is shown as table II.

TABLE II.
KEY PROCESS AREAS AND GOAL ITEMS

KPA	Specific Goal(SG)/Generic Goal(GG)
Requirements Management (REQM)	SG1:Manage Requirements
Project Planning (PP)	SG2 : Establish Estimates
	SG3: Develop a Project Plan
	SG4 : Obtain Commitment to the Plan
Project Monitoring and Control (PMC)	SG5: Monitor Project Against Plan
	SG6: Manage Corrective Action to Closure
Supplier Agreement Management (SAM)	SG7: Establish Supplier Agreements
	SG8: Satisfy Supplier Agreements
Measurement and Analysis (MA)	SG9 : Align Measurement and Analysis Activities
	SG10: Provide Measurement Results
Process and Product Quality Assurance (PPQA)	SG11: Objectively Evaluate Processes and Work Products
	SG12: Provide Objective Insight
Configuration Management (CM)	SG13: Establish Baselines
	SG14: Track and Control Changes
	SG15: Establish Integrity
	GG1: Systematize Managing Process

B. *Selection of Measurement Indexes*

In view of the fuzziness of the relationship between the measure of the goals in CMMI and the software process quality, and the expert evaluating is basic method for the CMMI implementation. Therefore, the methodology adopted in this paper is Delphi method. The measurement index system is built on the foundation that originates from practical implementation of several software projects such as “Real-estate Management Information System Online” designed by Anhui Kewei Information Technology Co. Ltd, and part of goals were screened from 16 goals. The source of experts includes: Hefei University of Technology, Anhui University, Anhui Agriculture University, Science and Technology Department of Anhui Province and Anhui Kewei Information Technology Co.Ltd. All the 20 questionnaires delivered were collected back, validity was 100%. Relevant data see table III.

TABLE III.
STRUCTURE OF MEASUREMENT INDEX SYSTEM

Specific Goal(SG)/Generic Goal(GG)	Number of Selected	Percentage of Selected (%)	Measurement Index System
SG1	13	65	G1
SG2	11	55	G2
SG3	18	90	G3
SG4	0	0	
SG5	10	50	G4
SG6	0	0	
SG7	2	10	
SG8	0	0	
SG9	6	30	
SG10	3	15	
SG11	10	50	G5
SG12	1	5	
SG13	10	50	G6
SG14	5	25	
SG15	0	0	
GG1	11	55	G7
	100	500	

It can be seen from table above that 5 key process areas in CMMI level 2 have been covered by 7 goals, which enjoy more than 50% selected rate, whereas key process area SAM and MA have not been covered. From an applicability perspective, SAM is not common to be involved in software project practice. Moreover, in reality, MA is more focus on building measurement goal system and collecting data for product, therefore it has intersection with key process area PPQA in the result. Consequently, it is certain reasonable that SAM and MA have not been covered. Based on it, this paper select 7 goals to create measurement goal system, i.e.

G=(G1,G2,G3,G4,G5,G6,G7).

III. DETERMINE WEIGHT OF MEASUREMENT INDEX

A. Construction of Judgment Metrics

Every measurement index shares different relative importance in quality management of software processing. Accordingly, determining weight of every index is a crucial job in optimizing processes. This paper relies on software project practice, and utilizes expert investigation method to collect original data, and then the judgment metrics is constructed. By following up with relevant theories of metrics, the weights of measurement indexes are determined by calculating characteristics root of matrix and characteristic vectors.

For parameters of every index, the degrees of relative importance adopt a numerical scale of 1 to 9[19]. The details are shown in Table IV.

TABLE IV.
SCALE OF 1 TO 9

Relative Importance between i and j	b_{ij}(Value of Importance)
Equal	1
Between Equal and Slightly Favors	2
Slightly favors	3
Between Slightly Favors and Strongly Favors	4
Strongly favors	5
Between Strongly Favors and Very Strong Favors	6
Very strong favors	7
Between Very strong favors and Extreme Favors	8
Extreme favors	9

To avoid conflicts among individual expert data and ensure validity of data, the data used in this paper initially are collected at their ratio of relative importance between two adjacent goals (recorded as D1); and then, for every index in measurement index system, the degrees of relative importance are collected in single ordering (recorded as D2); finally, if D1 and D2 exist conflict and it is happened in same expert, it will be ignored. Comparison Table V demonstrate 5 expert values in importance survey.

TABLE V.
PARTIAL EXPERT VALUE OF IMPORTANCE COMPARISON

expert	D1(Ratio of Relative Importance Between Two Adjacent Goals)						D2(Ringle Ordering)
	b_{12}	b_{23}	b_{34}	b_{45}	b_{56}	b_{67}	
1	3	1/5	6	3	4	1/6	G3 > G1 > G7 > G2 > G4 > G5 > G6
2	5	1/4	9	4	4	1/7	G1 > G3 > G2 > G7 > G4 > G5 > G6
3	3	1/5	8	4	1/3	1/7	G3 > G1 > G2 > G7 > G4 > G6 > G5
4	4	1/6	8	5	3	1/8	G3 > G1 > G2 > G7 > G4 > G5 > G6
5	6	1/6	7	5	4	1/5	G3 > G7 > G1 > G2 > G5 > G4 > G6

In order to explain the relevant problem, this table list one ignored expert values which are conflict with each other (expert 5). Among them, the fifth expert shows b_{45}=5, which represent the fifth expert believe item 4 is more important than item 5, it is conflict with G5>G4 in importance single ordering from this expert, therefore it is eliminated.

1) Parameter Description:

a) $A=[A_{ij}]_{7*7}$; A is a reciprocal matrix, A_{ij} is the value of the relative importance, which represent the i^{th} index relative to the j^{th} index.

b) $T=\{a, 1/a, a\in[1,9], a\in N\}$; T represent the integers from 1 to 9 and they reciprocals;

c) $P_i=(P_{i1},P_{i2},P_{i3},P_{i4},P_{i5},P_{i6})$; P_i is the assessment results of the i^{th} expert, P_{ij} is the assessment value for comparing of the j^{th} goal with the $(j+1)^{th}$ goal in relative important degree provided by the i^{th} expert.

d) $Q=(Q_1, Q_2, Q_3, Q_4, Q_5, Q_6)$; Q is the final result which is carried out by processing all assessments by these experts. Q_j is the comprehensive assessment value of all experts. Notice that $P_{ij}=(1/P_{ji})$ in reciprocal matrix, the value of Q_j do not equal to the simple average for all corresponding P_{ij}.

For example, $P_{11}=3$,$P_{21}=1/3$.If the first expert suggest the first goal is slightly important than the second goal, and the second expert hold the opposite view. The comprehensive assessment value of the two expert above is 1(the important degree of the first goal equal to the second goal),is not equal to the simple average of P_{11} and P_{21}.

e) $f(x)$ *definition:*

$$f(x)=\begin{cases}-\dfrac{1}{x}, x<1\\ x, x\geq 1\end{cases} \tag{1}$$

According to the definition of the function f(x),if $P_{ij}>=1$,then $f(P_{ij})= P_{ij}$; Otherwise, $f(P_{ij})=-(1/P_{ij})$.

For the comprehensive assessment value, Q_j is not a simple average of the assessment value of all experts, so an equation is formed below:

$$Q_j=\begin{cases}\dfrac{1}{n}\sum\limits_{i=1}^{n} f(P_{ij}),\ \sum\limits_{i=1}^{n} f(P_{ij})\neq 0\\ 1,\ \sum\limits_{i=1}^{n} f(P_{ij})=0\end{cases} \tag{2}$$

According to the equation (2),the value of the comprehensive assessment Q_j, equal to the average mean of all corresponding $f(P_{ij})$. Notice that $Q_j=1$ when the $\sum\limits_{i=1}^{n} f(P_{ij})=0$.

A is a reciprocal matrix, thus, equation available listed in blow.

$$A_{ii}=1 \quad (1<i<7,j=i+1,i\in N, j\in N) \tag{3}$$

$$A_{ij}=Q_j \ (1<i<7,j=i+1,i\in N, j\in N) \tag{4}$$

According to the logical implications of A_{ij}, it is a obvious fact that the value of A_{ij} is under the constraint of the value of A_{ik} and A_{kj}. So, this paper will calculate the value of A_{ij} and build the comparison matrix A according to the principles below.

2) The Principal of Adjustment:

a) Principle 1: $A_{ij}\in T$;

b) Principle 2: if $A_{ik}\in[1,9]$ and $A_{kj}\in[1,9]$, then A_{ij} equal to the larger of A_{ik} and A_{kj};

if $A_{ik}\in[1/9,1]$ and $A_{kj}\in[1/9,1]$, then A_{ij} equal to the smaller of A_{ik} and A_{kj}.

c) Principle 3: If the larger value of A_{ik} and A_{kj} is exceed 1, and the smaller is lower than 1, then

$$A_{ij}=\begin{cases} f(A_{ik})+f(A_{kj}),\ f(A_{ik})+f(A_{kj})>0\\ 1/\left|f(A_{ik})+f(A_{kj})\right|,\ f(A_{ik})+f(A_{kj})<-1\\ 1,\ f(A_{ik})+f(A_{kj})=0\\ 1/2,\ f(A_{ik})+f(A_{kj})=-1\end{cases} \tag{5}$$

d) Principle 4: This paper designs an adjustment mechanism to the value of A_{ij} which provided by the Principle 2 and Principle 3 for the consistency of subjective judgment.

If $A_{ij}>1$,then the value of A_{ij} is likely to change to $A_{ij}+1$ or $A_{ij}-1$.

If $A_{ij}<1$,then the value of $A_{ji}(A_{ji}=1/A_{ij})$ is likely to l change to $A_{ji}+1$ or $A_{ji}-1$.

Thus now comparison matrix is completed:

$$A=\begin{bmatrix} 1 & 2 & 1/3 & 4 & 5 & 6 & 2\\ 1/2 & 1 & 1/5 & 2 & 2 & 3 & 1/2\\ 3 & 5 & 1 & 7 & 8 & 9 & 5\\ 1/4 & 1/2 & 1/7 & 1 & 2 & 3 & 1/2\\ 1/5 & 1/2 & 1/8 & 1/2 & 1 & 3 & 1/2\\ 1/6 & 1/3 & 1/9 & 1/3 & 1/3 & 1 & 1/4\\ 1/2 & 2 & 1/5 & 2 & 2 & 4 & 1 \end{bmatrix}$$

B. Determination of the weight

For getting the weight of the each index, the method of multiplying all elements of each row of the comparison matrix A, calculating the 7^{th} root of the product of each row and normalizing the final result is adopted in this paper. The detail calculation processes are shown as table VI.

TABLE VI.
CALCULATING OF THE WEIGHT

Row of The Matrix A	Multiplying Continued Product	The 7^{th} Root of The Multiplying	Normalization
1	160	2.065	0.203
2	0.6	0.930	0.092
3	37800	4.507	0.444
4	0.0536	0.658	0.065
5	0.0094	0.513	0.051
6	0.0002	0.290	0.029
7	3.2	1.181	0.116

The value of the weight is listed as follows:

W=(0.203,0.092,0.444,0.065,0.051,0.029,0.116)

However, acceptance of the value of the W depends on the consistency assessing of the comparison matrix A.

In order to measuring the consistency of the comparison matrix A, consistency index(CI) should be brought.

$$CI = \frac{\lambda_{\max} - n}{n-1} \qquad (6)$$

$\lambda_{\max}$ is the largest Eigen value of the comparison matrix, and n is the size of the comparison matrix. According to the basic theory of the comparison matrix, the following formula will be used for getting the value of $\lambda_{\max}$.

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} \qquad (7)$$

Furthermore, the random consistency index(RI)will be brought for using the consistency index(CI) more effectively. The average random consistency indexes based on 1000 samples which are collected from the matrices are shown in the table VII[20].

TABLE VII.
THE VALUE OF THE RANDOM CONSISTENCY INDEX(RI)

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41

According to Table VII, the results are described as bellow:

$\because n = 7$

$\therefore RI = 1.36$

Now, the consistency ratio (CR)will be used to measure the consistency of the comparison matrix.

$$CR = \frac{CI}{RI} \qquad (8)$$

If the value of consistency ratio is smaller or equal to 0.10, the inconsistency of the comparison matrix is acceptable. Otherwise, the comparison matrix needs to be revised.

As mentioned above, the value of CI,RI and CR could be acquired by calculating:

$A \times W = (1.452, 0.657, 3.211, 0.470, 0.369, 0.210, 0.836)$

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{W_i} = 7.23$$

$$CI = \frac{\lambda_{\max} - n}{n-1} = 0.038$$

$$CR = \frac{CI}{RI} = 0.038/1.36 = 0.029$$

$$CR < 0.1$$

The inconsistency of the comparison matrix A is acceptable, for the reason that the value of consistency ratio is smaller to 0.10 and value of the weight is acceptable as well. Therefore, the value of W could be represented as follows.

W= (0.203, 0.092, 0.444, 0.065, 0.051, 0.029, 0.116)

IV. ESTABLISHMENT AND IMPLEMENTATION OF THE EVALUATION MODEL

A. Establishment of the Evaluation Model

Each specific goal (SG) or generic goal (GG) includes specific practices (SP) or generic practices (GP) in CMMI. e.g., these are five specific practices in the specific goal management requirements and seven specific practices in the specific goal project planning. the details of the specific practices in specific goals please refer to the CMMI for Development, Version 1.2[4].Table VIII demonstrate the examples of SP and GP.

TABLE VIII.
EXAMPLES OF SPECIFIC PRACTICES

SG	**SP**	**Description**
project planning	SP1	Establish the Budget and Schedule
	SP2	Identify Project Risks
	SP3	Plan for Data Management
	SP4	Plan for Project Resources
	SP5	Plan for Needed Knowledge and Skills
	SP6	Plan Stakeholder Involvement
	SP7	Establish the Project Plan
management requirements	SP1	Obtain an Understanding of Requirements
	SP2	Obtain Commitment to Requirements
	SP3	Manage Requirements Changes
	SP4	Maintain Bidirectional Traceability of Requirements
	SP5	Identify Inconsistencies Between Project Work and Requirements

1) Parameter Description:

a) V: Value of the Software Process Quality shown in different developing stages of software program.

b) G_i: Value of the index G1 to G7.Meanwhile, the value of i is 1 to 7.

c) SP_{ij}: Evaluation value of the j^{th} specific practice(or generic practice)in the i[th] index.

2) Hypothesis:

$SP_{ij} \in \{1,2,3,4,5\}$

The value of SP_{ij} is 1 to 5, which indicate that SP_{ij} is classified by five categories as worst, unsatisfactory, medium, satisfactory and excellent.

3) Definition:

$$G_i = \frac{1}{m_i}\sum_{j=1}^{m_i} SP_{ij} \qquad (9)$$

The value of the G_i equal to the average of all evaluation values for practices in the i^{th} index. The parameter m_i is the number of the practices in the ith index.

Therefore, the evaluation model for software process quality is available by the analysis above.

$$V = \sum_{i=1}^{7} G_i \times W_i = \sum_{i=1}^{7} (\frac{1}{n}\sum_{j=1}^{n} SP_{ij}) \times W_i \qquad (10)$$

$W_i = (0.203, 0.092, 0.444, 0.065, 0.051, 0.029, 0.116)$.

B. Implementation of the Evaluation Model

The primary purpose of this paper is going to apply CMMI methods into quality measurement of software development in enterprises especially in small and middle sized enterprises, so that to improve the ability of quality control. Depend on real software developing practice of certain software enterprise, above model and relevant methods are implementing in software project. The specific processes and results are briefly described:

1) Step 1: Setting 6 data collection time in specific software project (the times of collection could be modified according different enterprises and projects), the 6 data collected mainly set in needs, analyzing, designing, encoding, testing and deploying 6 stages.

2)Step 2: Collecting data once at every point of time, the main job of data collection is to evaluate relevant practices (SP and GP), the volume of evaluation is set 1 to 5.

There are two kinds of detail methods of data collection:

The first is the enterprise self evaluation; the second is expert evaluation, therefore two groups of value SP and GP are collected; denoted as SP_{ij} and $SP_{ij}^{'}$.

3)Step 3: According to SP_{ij} and $SP_{ij}^{'}$, and refereeing equation (9), calculating G_i and $G_i^{'}$ separately.

4)Step 4: According to G_i, $G_i^{'}$ and the value of weight W_i, and refereeing to equation (10), calculating relevant V. Because 6 times of data collection are set, the two kinds of methods of data collection are denoted as:

$V = (V_1, V_2, V_3, V_4, V_5, V_6)$:6 enterprise self evaluation.

$V' = (V_1', V_2', V_3', V_4', V_5', V_6')$: 6 expert evaluation.

This paper omit detailed value, thus the analysis, relevant results and suggestion to those data are all omitted. The diagram of evaluation values is shown as Figure 2.

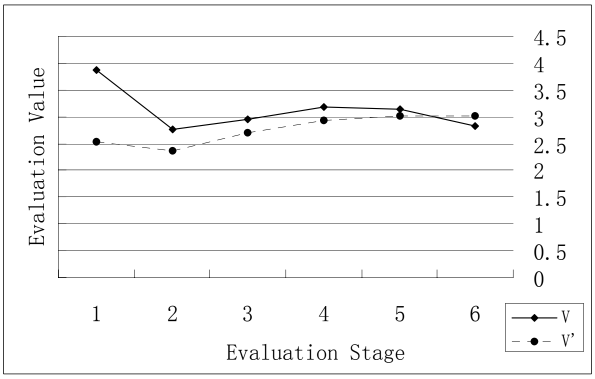

Figure 2. Diagram of Evaluation Values

It is seen as Figure 2 that expert curve displays an relevant stable trend comparing with enterprise self evaluation. In the initial stage of this project, a great difference shown in expert value and enterprise self evaluation, while in the stage of project completion, the situation has been changed into smaller gap relatively. It shows that the enterprise is clearly more optimistic in the beginning of this project and hold objective and conservative view in the last stage of this project. Therefore, it is necessary and effective to establish independent evaluation unit and implement quality test.

Besides, the practices (SP and GP) with lower value will be the factor requires more attention to improve software developing capability in the future. While, the practices (SP and GP) with higher value represent that enterprise is uncertain in evaluation methods or concepts, which a great importance need to be paid.

Also, on the basis of difference of evaluation indexes described in above, the enterprise should pay more concern to those specific practices with highly weighted goals in implementing software process quality measurement.

The cyclic implementing basic method of CMMI-based appraisal in the different stages of entire software processing will provide timing quality data and trends of change for decision maker. Furthermore, it could also deliver a kind of low cost and high efficiency assessment method for s software enterprises at level 2 and below, which are involved in different software project according to different stages. Thus, it will provide sustainable quality assuring support in software developing process of software enterprises.

V. CONCLUSION

As an important model for appraising the ability of software developing, the method of CMMI demonstrates tremendous referencing significance in every stages of software project. Obviously, appraising enterprise and the measures and methods, which are presently used in

CMMI, are transferred in to the entire process of software designing and developing, will play a significant function of enhancing quality management of software processing for enterprises.

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