Research on KPA of Quality Management System --in the view of carbon emission and cloud computing

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***Abstract*—With the development of technology and quality management, quality management has become a comprehensive subject, and the field it involved is more complicated. Environment has be considered in quality management. And carbon footprint has become the hot topic in the quality management. This paper aimed to study key process areas of quality management system on the view of carbon footprint and cloud computing. With integrated technology and method, advices on the developing of quality management had been made.**

Keyword-carbon emissions; CMMI; capability index; Quality Management System; Key Process Area

I. Introduction

In recent decades, the international quality standards of ISO9000, 6 sigma and CMMI (Capability Maturity Model Integration) have formed some kind of market forces. In which CMMI is a quality maturity model to software products and is recognized internationally. With more attention to the information resource utilization and carbon emission accompanying resource consumption, the applications of them are going deeper. Meanwhile, to measure products in regard to their effects to the environment, the integration and complementarity of computing of carbon emission and cloud computing with quality management system become necessary for the demand of environment protection. The following examples introduce the applying of computing of carbon emission and cloud computing.

As more and more attention is paid to the low-carbon economic, people have to think about approaches to achieve it. Obviously, both of merging carbon footprint management to the evaluation index system and the calculation of carbon emissions capability are the key studying fields.

To calculate a enterprise or a family`s carbon emission, there are usually 4 steps:

(1)Choose the gas used for calculation
(2)Find the usage of fuels
(3)Query carbon emission factor
(4) Calculate carbon footprint

CO_2 is the main part of gas emission, but the effect of kinds of gas for global warming is different. To measure the influence of various greenhouse gases on global warming, IPCC had published data tables about the impact of various gases on that problem.

Each greenhouse gases has different influence on greenhouse effect, to international practice, CO_2 gas`s GWP value is 1, ratios of other greenhouse gas effects and CO_2 effect is the GWP value (generally outweigh the CO_2GWP value).To transform other gases to CO_2 with the same effect, just need to multiply corresponding GWP. And then the carbon footprint of each gases can be calculated directly.

There are also kinds of CO_2 emission factors on daily work and life, such as factors of electricity and heating. Carbon footprint can be also calculated by that factors indirectly.

From the data Illinois waste management and research center collected the in 2007, electricity is 159450 KWH, and natural gas usage is 159450 kilocalorie. So we can calculated the carbon footprint by the method above.

CF of electricity= electricity of 2007 * carbon footprint factor of electricity=1594500 KWH *1.77 pounds per kilowatt-hour (carbon footprint factor of electricity) = 2822265 pounds

CF of natural gas= natural gas usage of 2007 * GWP of natural gas=96850 kcal * 11.698 pounds per kcal (GWP of natural gas) =1132951.3 pounds.

II .Cloud computing cases

A. Cloud computing cases of IBM

This project builds upon the business demands of the IBM Smarter Education project. A collection of Cloud Computing was envisaged based services ranging from operations, education tracking, delivery, and classroom instrumentation. In this system, educational institutions will be able to contract services on-demand, saving time and improving the efficient.

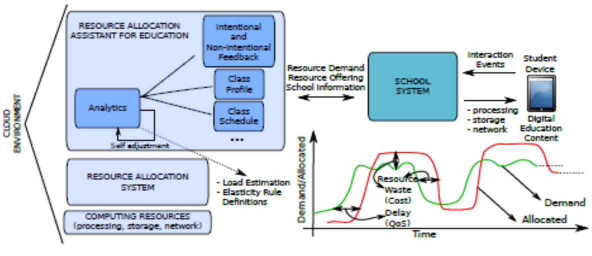

Fig.1 Architecture for dynamic resource allocation using education information.

The typical requirements of some multimedia communication simulations typically used in research . The most important part of the dataset in multimedia experiments is the video sequences. Generally sequence length ranges from 6 to 10 s at 30 frames per second, i.e., 180–300 frames. The corresponding size in bytes ranges from about 26 MB up to 890 MB depending on video resolution, from CIF (352 × 288) to FullHD (1920 × 1080). Typically, four or five video sequences are enough for representing a range of video contents suitable to draw reliable conclusions. Since results are computed as the average performance over different channel realizations, to achieve statistically significant results from 30 to 50 different random channel realizations are required.

B. Cloud computing experiment of CUEB

Based cloud computing method and corresponding software, we had built a mini cloud computing system with 4 servers.

Four servers were select as test platform under the tested environment, the concrete disposition was as follows: HP Proliant DL380 G5, x Intel(R) Xeon(R) CUP 5110 1.60GHz and 4 GB Menory. And we also have computers with some disposition for controlled experiments

These four servers are serves for students to do experiment. Each server installs an operating system, embarked a duty. Server utilization rate as follows:

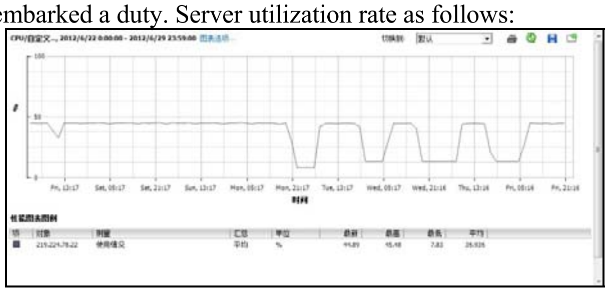

Fig.2 CPU utilization of A

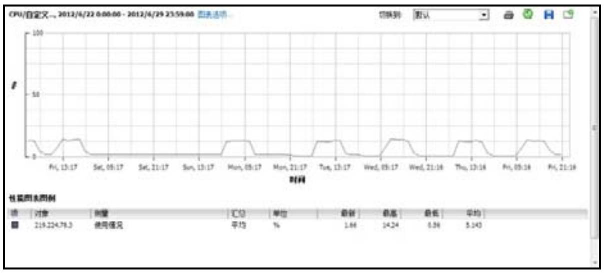

Fig.3 CPU utilization of B

Table.1 Utilization of CPUs

Servers	IP	Mean utilization of CPU(without cloud computing platform)	Mean utilization of CPU (%)	Maximum utilization of CUP (%)
Application Servers	219.224.78.22	17	36.936	44.89
DB Servers	219.224.78.3	0	5.143	14.24

After building cloud computing platform, the number of servers had been reduced, almost resource of 3 servers had been saved.

Moreover, after building could computing platform, the utilization of CPU had improved a lot, utilization of application severs had improved from 17% to 36.936%, and DB severs had improved from 0 to 5.143%.With the help of cloud computing platform, the number of servers had reduced twice. We could finish the same work with only 2 servers what we used to work with 6 servers.

As shown above, computer involved in the cloud computing system had a higher utilization than another, cloud computing system can help more students to do their experiments by the ability of resource sharing .

III. USING CMM ON MANAGEMENT OF CARBON EMISSIONS TO AVOID MANAGEMENT RISK OF SOFTWARE COURSE

A .Avoid management risk of software course using CMM

In CMM system, there are 18 key process areas, as shown in fig.1. CMM. It contains the important infrastructures and activities of quality management, and have a standard for management level. With the help of CMM, quality can be controlled effectively.

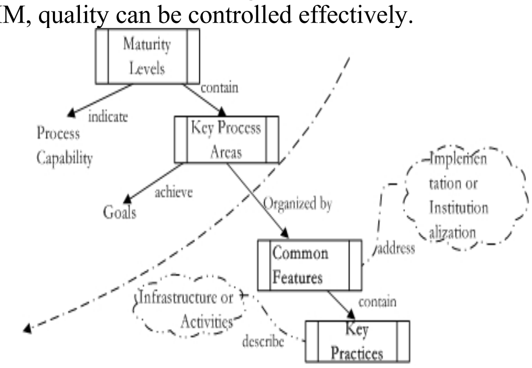

Fig.4 Common Features and Key Practices

Drawbacks of managements may be different because work in each stage in software project is different, and it is different from the management with reinforced focal.

Therefore, according to the stage management risk of software project, we establishment a connection between stage of software project and key process area of CMM. In frame it has described that each stage in software development should use references particularly in the key of CMM. As shown in table 1.

Table.2 connection between stage of software project and key process area of CMM

Key Practices Area / The stage of development	Crucial Key Practices Area	Normally Key Practices Area
Project is prepared and planed	Software Project Planning Software Configuration Management Training Program Defect Prevention	Software Product Engineer Software Subcontract Management
Demand analyze	Requirements Management Organization Process Definition	Organization Process Focus
System designs	Software Project Tracking and Oversight	Peer Reviews
System implements	Software Quality Assurance	Intergroup Coordination
Appraise and defend	Software Configuration Management Base line manage	Technology Change Management Process Change Management s

What need explanation is that every KPA of CMM does not be to face a certain specific course, they take effect during entire development course, so above-mentioned form do not hinder the crucial guidance role of KPA for whole course .But after all the different stages in development course, the management problems are easy to appear and technology demands are not identical, so the application of KPA should have to be stressed or cut down.

As we know, software products, like other products, go through a life from birth, growth, maturation to recession. According to the project scale and users' demands, developers can select development methods such as the combination of life period method and prototype method, or object-oriented method. Appropriate deduction and addition to the mergence frame can be followed when the method is chosen. But some crucial KPA can not be lacked such as software project planning, software configuration management, training program and so on.

We have summarized above-mentioned form frame as simple and practical as possible. In view of the fact that there is more specific content of CMM details, here, we not give unnecessary details again.

B. Avoid management risk of software course using CMM on the management of carbon emissions

Table 3 CMM of carbon emissions

Level	Capability
Initial	No standard on carbon emission
Repeatable	Planning and management on KPA of carbon emission
Defined	Unified standard on carbon emission management
Managed	Carbon emission management with engineering technology
Optimizing	Carbon emission management with early warning mechanism

In order to realize the target of low-carbon, we do system researches on the management of carbon emissions. With structured management, carbon emission management will be embedded in the CMM model. Specific include :no management of carbon emissions in chaos level, standard management of carbon emissions in 2 level which put requirements of carbon emissions in planning, demand, configuration, quality assurance and other key process areas, unified management of carbon emissions in 3 level which add unified management of carbon emissions to the focus and definition of organizational process、training programs and other key processes, quantitative management of carbon emissions in 4 level to control carbon emissions through the engineering technology, early warning level of the management of carbon emissions in 5 level, aiming to defect prevent defects of carbon emissions .

Ⅳ.THE COMPUTATION OF SIGMA LEVEL ABOUT CARBON EMISSIONS

The concept of 6 Sigma was proposed by Bob Galvin, Chairman of Motorola in 1987. Six sigma, which is popularized and applied gradually by the MOTOROLA, American general electric (GE), IBM, Allied Signal and so on, analyses the quality quantitatively by the statistical parameter "σ" to identify the defects and then improve them, so as to realize the quality creation and customer satisfaction. We can see that, first of all, 6 sigma is a statistical concept; Secondly, six sigma is a promotion to establish the concept and culture of efficient quality; last but not the least, the six sigma is an enterprise strategy held on by the whole the company. The following two methods are included in computing sigma level.

A. The computation of defects per million opportunities about carbon emissions

According to the following formula to compute DUP(defects per unit)

$$DUP = \frac{total\ number\ of\ defects}{total\ units}$$

According to the following formula to compute DPMO (defects per million opportunities):

$$DPMO = \frac{number\ of\ defects}{number\ of\ units \times number\ of\ opportunities} \times 10^6$$

So the DPMO of carbon emissions compute as following:

$$DPMO\ of\ carbon\ emissions = \frac{number\ of\ carbon\ emissions\ defects}{number\ of\ units \times number\ of\ opportunities\ per\ unit} \times 10^6$$

DPMO values corresponding to various sigma levels are represented as table 2.

Table.4 DPMO values corresponding to various sigma levels.

Sigma level	DPMO	Sigma level	DPMO
1．5	500000	3．7	13904
1．6	460172	3．8	10700
1．7	420740	3．9	8198
1．8	382088	4．0	6210
1．9	344578	4．1	4661
2．0	308537	4．2	3467
2．1	274253	4．3	2555
2．2	241964	4．4	1866
2．3	211856	4．5	1350
2．4	184060	4．6	968
2．5	158655	4．7	687
2．6	135666	4．8	483
2．7	115070	5．0	233
2．8	96800	5．1	159
2．9	80757	5．2	108
3．0	66807	5．3	72
3．1	54799	5．4	48
3．2	44565	5．5	32
3．3	35930	5．6	21
3．4	28717	5．7	13
3．5	22750	5．8	8．6
3．6	17865	5．9	5．5
		6．0	3．4

B. Calculation of capability index

From the figure 2, we can see that Cp and Cpk are two significant process capability indices.

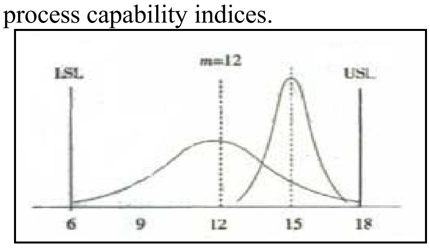

Fig.5 Process capability

Cp estimates what the process would be capable of producing if the process could be centered. Assumes process output is approximately normally distributed.

$$C_p = \frac{customer's\ requirement}{6\sigma} = \frac{USL - LSL}{6\sigma}$$

If it estimates the capability of carbon emissions management, customer requirements in the above formula should converted into the customer's requirements on carbon emissions.

Cpk estimates what the process is capable of producing if the process target is centered between the specification limits. If the process mean is not centered, C_p overestimates process capability. Assumes process output is approximately normally distributed.

Cpk =min [(USL–μ)/ 3σ),(μ–LSL)/3σ)]

Where: we use the following notation:

USL: upper limits of the process

LSL: lower limits of the process

σ: Standard deviation

μ: The average of the process

In short, CMM and computing sigma level are not only essential to the research on capability calculation and evaluation system of carbon footprint, but also contribute to help improving the process capability and process capability maturity, hierarchy evaluation of carbon emissions management and calculation of the capability of carbon emissions are important approaches to realize carbon emissions management.

Introducing carbon footprint and cloud computing in key process areas of quality management, and make experiments in the lab with students involved. Author had got a lot of teaching experience and had found a system of quality management teaching. What`s more, increasingly results had been made on the study. More research still need to be made on that method.

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