Sudan University of Science and Technology
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Customization of CMMI Model for Small Enterprises in Sudan

تكييف نموذج CMMI للشركات الصغيرة في السودان

A thesis Submitted for the Partial Fulfillment of The Degree of M.Sc. in Computer Science in Software Engineering

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الاستهلال

قال الله تعالى :

﴿لاَ يُكَلِّفُ اللّهُ نَفْسًا إِلاَّ وُسْعَهَا لَهَا مَا كَسَبَتْ وَعَلَيْهَا مَا اكْتَسَبَتْ رَبَّنَا لاَ تُؤَاخِذْنَا إِن نَّسِينَا أَوْ أَخْطَأْنَا رَبَّنَا وَلاَ تَحْمِلْ عَلَيْنَا إِصْرًا كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِن قَبْلِنَا رَبَّنَا وَلاَ تُحَمِّلْنَا مَا لاَ طَاقَةَ لَنَا بِهِ وَاعْفُ عَنَّا وَاغْفِرْ لَنَا وَارْحَمْنَآ أَنتَ مَوْلاَنَا فَانصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ﴾

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صدق الله العظيم

Dedication

This work is dedicated to

my parents who influenced

my life

to my sisters, my brothers, my friends

and to my husband who will always be my pillar of strength

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All thanks to Allah for giving me the power and patience to achieve this work which I wish to be useful and objective .

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Table of Abbreviations

Abbreviation	Full meaning
(CMMI	Capability maturity model integrity
PP	Project Planning
REQM	Requirement management
CM	Configuration Management
RSKM	Risk Management
SP	Specific Practices
SPI	software processes improvement
SMEs	Small and medium enterprises

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Abstract

Sudanese software enterprise which categorized as small enterprises need frameworks and models for process improvement . Capability Maturity Model integration (CMMI) which is designed for large scale enterprise is not suitable for Sudanese enterprise and need to be customized to suit small enterprise . The current study aims to investigate software process improvement in Sudanese software enterprise and to customized process improvement. Capability Maturity Model integration (CMMI) model for Sudanese enterprise. The study highlighted several questions covering all the activities in CMMI model a questionnaire was distributed among developers , project managers and researchers in the software engineering field. The data from the questionnaire was collected from a sample of 50 subjects and analyzed. The result of the study showed that companies used the first level from CMMI model and some activities or practices from other levels this was due the inexperienced , small number of staff . also all tasks are based on the developers . Organizations use different terminologies from Capability Maturity Model integration (CMMI) terminology and beside that roles and groups defined in CMMI are not present in the organization enterprise . Special standard or frameworks based on CMMI was proposed in order to improve and quality of the process. This study contribute to improving products quality and team performance , and this is reflected on the time and effort required to accomplish any project . The current study concluded many recommendations that must be adhered, Ensure success to apply software quality standards in the small enterprises, Providing software quality standards meet small enterprises needs must be merge more than one software quality standard , Applying CMMI model on small enterprise meets their needs and enough to improve their software development process maturity and resorting to experts foreign , and some country which used this models.

المستخلص

مؤسسات البرمجة السودانية التي تصنف كمؤسسات صغيرة تحتاج لاطار لعملية تحسين البرمجيات. و نماذج لتطوير العمليات مثل نموذج CMMI الذي صمم للمشاريع الكبيرة والواسعة النطاق والذي لم يكن مناسبا للمؤسسات الصغيرة لذا يحتاج لتكيف حتي يتناسب معها . تهدف الدراسة الحالية لتكيف نموذج تطوير البرمجيات CMMI للشركات السودانية حتي تحقق عملية تطوير برمجياتها بصورة خاصة . ابرزت الدراسه عده اسئلة تغطي كافة الانشطه في نموذج نضج القدرة المتكامل (CMMI) ، تم نشر إستبيان وسط قطاعات المطورين، مدراء المشاريع والباحثين في مجال هندسة البرمجيات استهدفت خمسين عينه لاثبات صحة الاسئلة ومن ثم تم تحليل البيانات بناء علي مقياس ليكارت الخماسي للوصول الي نتائج واضحة ودقيقة اتساعد في تصميم منهجية الحل المقترحة اظهرت نتائج الدراسة ان المستوي المستخدم من هذا النموذج هو المستوي الاول ,اما بالنسبة للمستويات الاخري فيستخدم في اي مستوي منها بعض النشاطات, وذلك بسبب عدم الخبرة الكافية وقلة عدد الموظفين وعدم توزيع المهام علي فريق العمل حيث ترتكز علي المطورين فقط الذين ليست لديهم الخبرة الكافية . وايضا المصطلحات المستخدمة في هذا النموذج تختلف عن المصطلحات المستخدمة في هذه الشركات . منهجية الحل المقترحة وضعت المستوي الاول كما هو في النموذج القديم اما بالنسبة للمستويات الاخري ففي كل مستوي وضعت النشاطات التي تستخدمها تلك الشركات واستبعاد النشاطات التي لم تستخدمها هذة الشركات . يمكننا وضع المعيار الخاص او الا طار الخاص من نموذج CMMI لهذه الشركات حتي تستطيع تحسين برمجياتها ورفع جودتها حتي يكون السودان من الدول المنافسة في سوق انتاج البرمجيات . تسهم هذه الدراسة في تحسّين نوعية منتجات هذه الشركات ، ويحسّن أداء فرقهم وينعكس هذاعلى الوقت والجهد لإنجاز أيّ مشروع . إستنتجت الدراسة الحالية العديد من التوصيات التي يجب أن تلتزم بها الشركات , ضمان النجاح لتطبيق معايير جودة البرمجيات في المشاريع الصغيرة , يجب دمج اكثر من معيار في معيار واحد يناسب حاجات المشاريع الصغيرة, تطبيق نموذج CMMI على المشاريع الصغيرة بما يقابل حاجاتهم وبما فيه الكفاية لتحسين نضج عملية تطوير برامجهم , الجوء إلى الخبراء الأجانب، وبعض البلاد التي إستعملت نموذج نضج القدراتالمتكامل.

CHAPTER ONE
Introduction

1.1 Background

Choosing an appropriate model and ensuring its compatibility with an organization's characteristics and business strategy is the first step of the process of founding a mature organization . CMMI (Capability Maturity Model) for software developed by the Software Engineering Institute has had a major influence on software process and quality improvement around the world, especially in the United States and Europe. But until now no software organization in Sudan had its certificate. this standard causes higher confidence for foreign corporations. Most organizations in Sudan , still don't use up-to-date systems, especially integrated systems. Great weakness is observed in project management of large scale software projects. These problems might cause great delays and they can even make a project fail. All these facts have put the Sudan away from the competitive business world. The software CMMI is focused on large projects and large organizations 75% of organizations in Sudan have fewer than 20 staff It seems that CMMI must become customized to small organizations both in scale and the application procedure.

1.2 Research problem

Sudanese software enterprises which categorized as small enterprises need framework for process improvement also models for process improvement such CMMI which is designed for large scale enterprise is not suitable for Sudanese enterprise and it need to be customized to suit small enterprises .

1.3 Objectives of The Study

To investigate software process improvement in Sudanese software companies to customize process improvement CMMI model for Sudanese enterprises .

1.4 Research Methodology

The questionnaire was distributed to the target companies, this method included some of the activities and practices of the task maturation integrated capabilities that help companies improve software process model. To see if the model was applied or not and what are the gaps and problems facing these companies and developing appropriate solutions. The proposed solution will depend on the answers to the developers, researchers, project managers and each one has to do software development.

1.5 Motivation

The small enterprises seeking to profit quickly and reduce the expenditure for limited resources as well as lack of full-time staff to implement and monitor the software process improvement or software process improvement standards. can summarize the most important factors that make difficult to apply these software quality standards at the national market as follows

1. Lack s for staff with experience, knowledge and specialists in the software quality standards and on the other hand it is difficult allocation staff for this mission because there are limited number of staff in small companies.
2. Top management's lack of knowledge in relation to the applying the software process improvement and software process improvement standards.
3. Lack of cooperation between the customers and project owners to presence and provide their views and suggestions as one of the most importance project management practices.
4. Project size and complexity, budget allocated, number of team members that involved to development process all these factors that directly affect on to apply software standards. All this lead me to work model simple and easy using in small and medium enterprise.

1.6 Signification

Software process improvement should be done to help the organization. This is true for both large organizations and small. Although, CMMI is intended to focus on large projects and organizations a procedure could be designed to make it applicable to small organizations as well.

1.7 Contribution

This study contribute is to improves their products quality, improve their team performance reflected on the time and effort required to accomplish any project

1.8 Thesis Structure:

This study was contain six chapter, chapter one that include , introduction background, problem of the study, objectives, motivation , signification , contribution ,chapter two include literature review. Chapter three include methodology of study, place and time of the study. Chapter four include result , and discussion chapter five The proposed customized chapter six conclusion and recommendation

and finally references and appendix .

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Software in last few decades become depend it mainly in our live, so now the software production is not like Traditional and mere programming activities become engineered under the specific practice and standards to improve the quality of a software and development effort.

Develop , serve, innovate or extend a software product (Deepti2011) .

This chapter summarizes. what is the software quality standers, why we need software quality standers and why we need to be sure and control software quality, the most important software quality standers for assessment and improvement, the most important practices and maturity model, Previous studies discussed problems for applying software quality standards in small and medium enterprises and studies have attempted to develop solutions for applying software standards in small and medium businesses.

2.2 About The Software Process Improvement (SPI)

The software process improvement is initiated to achieve the quality of the software processes which lead to quality of final software products. Software processes are improved by implementing software process standards. These standards are often called software process improvement frameworks or standards. Software process improvement is necessary to increase the efficiency and productivity of software companies and enhance the final software products. However, most of the Sudanese software companies do not follow any software process improvement standards. For this reason, normally these companies produce the software without high quality. Furthermore, the low quality may be the cause of some problems such as unreliable software and high maintenance. Some of the Sudanese software organizations were visited, to interview software experts and observe how these organizations can improve their software process. Furthermore, the results of these interviews have been used to design a questionnaire in order to show the relationship between Sudanese software organizations and software process improvement standards. This study has identified the problems faced by these organizations during the implementation of software process improvement standards and shows the ability of these organizations to implement the software process improvement standards. This questionnaire is distributed to 28 respondents in Sudanese software organizations to collect and analyze the data. Finally, the problems faced by these organizations

during the implementation of the Software Process Improvement Standards (Adb-algager 2013) .

2.3 Capability Maturity Model Integrity (CMMI)

CMMI is the abbreviation Capability Maturity Model Integration is a process improvement model developed by the Software Engineering Institute, Carnegie Mellon University. CMMI was developed from the software Capability Maturity Model Integration (SW-CMMI) which was used widely by software organizations throughout the world. Additional disciplines are included in CMMI. Software Park introduced SW CMM to Thai SW industry in 1999 and transit to CMMI about three years ago. CMMI aims to provide a systematic and an organized approach towards the development of software. Software improvement is also a part of software development; CMMI provides a framework which acts as the basis for improvement and maturity of the software. There is hundreds of software developed each day hence choosing one out of many becomes challenging therefore CMMI makes the decision easy.

The SEI published in 1995 the book, "The capability Maturity Model: Guidelines for Improving the Software Process". This was the start for CMMs (Capability Maturity Model) for software organizations. To evolve and improve the models for businesses three different CMM models were combined to the integrated one, CMMI. The capability model for software (SW-CMM), the systems engineering capability model (SECM) and the integrated product development capability maturity model (IPD-CMM) were combined to CMMI (Len Estrin , Bill Anderson. In "CMMI- Guidelines for Process Integration and Product Improvement", in the SEI series describes the CMMI framework in details. In the introduction to the book the purpose of CMMI for development is said to be "to help organizations improve their development and maintenance processes for both products and services. Business objectives are motivators for using the CMMI. "Process helps an organization's workforce meet business objectives by helping them work smarter, not harder, and with improved consistency." CMMI can be used for:

1. Software Engineering Discipline
2. Hardware Engineering Discipline
3. System Engineering Discipline
4. Integrated Product and Process Development

The maturity model consists of 5 levels or stages. Each level has a defined process area on which it focus. As the Level increases from 1 to 5, the quality also increases. Each maturity level must have clear and rigorous processe

The maturity model consists of 5 levels or stages. Each level has a defined process area on which it focus. As the Level increases from 1 to 5, the quality also increase. Each maturity level must have clear and rigorous processes and is shown as a step of stairs.

1. Initial: At maturity level 1 process are ad hoc and uncontrolled. Organizations on maturity level 1 significantly exceed budgets and cannot hold timeframes in schedules. They do get products finished but it all depends on heroic achievements of employees and successes are hard to repeat

2. Managed: At level 2 processes and practices based on policies are established. Projects are monitored and managed according to skills of employees, documentation, stakeholders etc.

3. Defined: At maturity level 3 processes are described in more detail compared to level 2. The processes are more sophisticated; more organized and have an organizational identity.

4. Quantitatively Managed: At maturity level 4, the organization establishes quantitative objectives for quality and process performance and uses them as criteria in managing processes.

5. Optimizing: Maturity level 5 focuses on continually improving process performance through incremental and innovative process and technological improvements. It is the role of the Executive in an organization to understand the CMMI implementation. It has certain responsibilities such as:

a. Make commitment by announcing CMMI policy.

b. Sending staff to learn Intro to CMMI course.

c. Sending staff to learn Project Management course.

d. Sending staff to learn Quality Assurance course.

e. Sending staff to learn Configuration Management course.

f. Allocate recourses to acquire project management and CMMI tools.

And last but not the least is to select pilot projects for implementation. In a process there are certain components in the CMMI model. There are 22 process areas in CMMI. Examples of process areas related to software development

 Project Planning(PP)

- Requirement management(REQM)
- Configuration Management(CM)
- Risk Management(RSKM)

LEVEL	MAIN FOCUS	ACTIVITIES INVOLVED	QUALITY FACTOR
5: Optimized	Focus on process improvement	•Organizational Innovation • Causal Analysis	HIGH
4: Quantitatively Managed	Process measured and controlled	•Organizational Process Performance •Quantitative Project Management	
3: Defined	Process characterized for the organization and is often proactive	•Requirement Development •Technical Solution •Integration •Verification •Validation •Organizational Training •Risk Management •Decision Analysis and Resolution	
2: Managed	Process characterized for projects and is reactive	•Requirement Management •Project Planning •Project Monitoring •Supplier Agreement Management •Measurement •QA •CM	
1: Initial	Process unpredictable, poorly controlled and reactive		LOW

CMMI Components To say that CMMI gives greater support for software development is not that obvious. CMMI does not get too involved in certain technological factors or unique activities. The processes and procedures are the means to the goal and have main focus. So as a conclusion higher CMMI maturity levels give more mature processes, in a general way, and there is the possibility to focus on maintenance processes and there is explicit support for this in half the process areas (Poonam and Anil 2014). With CMMI, companies can simultaneously make decisions about how much range improvement process that they want to achieve. A large number of the organizations that develop software around the world are small in size (between 10 and 100 employees). Many of the smaller companies oppose the CMMI model due to the expensive compliance effort, both in time and Among the shortcomings encountered in applying CMMI to software process improvement in smaller organization, it was identified that many of the SP's do not apply, such as Supplier Software Subcontract Management. Almost all small projects do not require external services (Leung 2001), while other ones require tailoring (Jeff 2005).

2.3.1 CMMI Benefit

Benefits associated with CMMI models are improvement in productivity , quality increase cycle time thus improving the customer satisfaction meeting and business in objective . CMMI helps organization discover the true value they can deliver by building capability in there people and processes , CMMI is defacto standard for process improvement and organizations use CMMI to elevate performance ,CMMI adoption rate and how global adoption of CMMI performance improvement framework continues to rise. capability maturity model integration (CMMI) is a process improvement approach that provides organisations with the essential elements of effective processes that ultimately improve their performance .

2.3.2 Applying CMMI to Small Organizations

Some references(Abbott 1997), define a small organization as fewer than fifth software developers and a small project as fewer than 20 developers. Also, an organization with fewer than twenty people is considered extra small we define small organization those who have between five and twenty staff , and medium between twenty five- two fifties handred. Also There are several factors affect on the implementation of SPI for SMEs include (Amiti 200): (1) Insufficient project candidates from formal assessment, (2) insufficient sponsor commitment to allocate appropriate resources to meet the needs and fulfillment activates, (3) lack

of training of the professional and leaders in software engineering, (4) inappropriate or non-existing tools to supports the SPIs implementation, (5) size of target companies as regarded the competition for improvement projects, (6) overestimated capacity of business managements and process control of the team. - Lack of guidance in satisfying project and development team needed and many small companies oppose the CMMI module due to expensive compliance effort, both in time and money (Abbott1997), other factors as (Basili and Rombach 1998) Top management's lack of knowledge in relation to follow SPI, Lack of cooperation between the customers and project owners to presence and provide their views and suggestions.

A general overview of SW-CMMI shows that there are more goals, andmore key practices related to many key process areas. Also it proposes more than twenty roles, responsibilities and tasks Using SW-CMMI in small organizations, where usually their prime goal is to survive, seems not to be reasonable. An obvious reason is that there is not a consistency between the number of roles, responsibilities and tasks to be done with the number of staff available in a small organization. Most of the time there won't even be enough people to fill these roles and take part in groups failure would be very likely. Considering the success of CMMI in many organizations around the world and its focus on continuous process improvement, if CMMI can be scaled down in size and other matters, it would be very helpful. By use of CMMI the organization can also grow and extend its scope of work and in this case, it won't be a small organization any more. Among the shortcomings encountered in applying CMMI to software process improvement in smaller organization, it was identified that many of the SP's do not apply, such as Supplier Software Subcontract Management. Almost all small projects do not require external services (Fugetta 1994)(Paulk), while other ones require tailoring (Brodman and Jonson 1995) (Poonam 1993) . These difficulties are closely related to the underlying philosophy of CMMi.In small teams the quality of the development group is very important for favorable results, high levels of abilities and experience generates quality in the products (Amiti 2001)(Richardson 2001) .The team cannot dedicate a lot of time to administrative procedures or documentation. The time is largely dedicated to the design, programming and

tests of the product (construction of the software).Some research with teams of similar size (smaller people) that adjusts the CMMI in small projects

through a tailoring of the process (Jeff 2005)(Richardson 2001). The results are reported in documentation reduction and invested effort, maintaining the quality of the software, reducing the cycle through control formats and documentation in short projects.

2.4 How Need Software Quality

Software quality standards guide project managers, developers or others development team to make sure the software development process, progressing correctly from the early stages of the software product life cycle based on a set of steps and activities that must be followed in turn reflected on the quality of the product, development time and cost. Generally can summarize the benefits of software quality standards in the following: (Ahmed 1999) .

1. The ability to apply methodologies and procedures of the highest professional level.
2. Better mutual understanding and coordination among development teams but especially between development and maintenance teams.
3. Greater cooperation between the software developer and external participants in the project.
4. Better understanding and cooperation between suppliers and customers, based on the adoption of standards as part of the contract.

Quality assurance (QA) is a process use to ensuring that a company or organization is providing the best possible products or services. It is focuses on the end result, such as testing and focuses on enhancing and improving the process that is used to create the end result, rather than focusing on the result itself. Among the parts of the process as planning, design, development, production and service.

Quality control (QC) is a set of procedures intended to ensure that a software product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer. QC is not identical with, quality assurance (QA). QA is defined as a procedure or set of procedures intended to ensure that a product or service under development (before work is complete) meets specified requirements. QA is sometimes expressed together with QC as a single expression, quality assurance and control (QA/QC).

In order to implement an effective quality control program, an enterprise or development team must first decide which specific standards the software product

or service must meet. Then the extent of quality control practice must be determined. Real-world data must be collected for example, the percentage of units that fail and the results reported to management. After this, corrective action must be decided upon and taken for example defective units must be repaired or rejected and poor service repeated at no charge until the customer is satisfied or achieving requirement correctly. If too many unit failures or instances of poor service occur, a plan must be devised to improve the production or service process and then that plan must be put into action. Finally, the quality control process must be ongoing to ensure that remedial efforts, if required, have produced satisfactory results and to immediately detect recurrences or new instances of trouble.

2.5 Related Studies :

In this section, we will look to a study about *The* Impact of Software Process Improvements in Small Scale Enterprises, the main objective of study is proposes new software process model that can be used in small enterprises. A new model is proposed based on the traditional software process development models such as Capability Maturity Model (CMM), Capability Maturity Model Integration (CMMI), and International Organization for Standardization (ISO) and Software Process Improvement Capability Determination (SPICE) (Kitchenham and fleeger 2002). Study revealed there are basically large gains to be made within the industry by the wider implementation of SPI, but as yet the use of models such as CMMI within small organizations has been limited. There is a general agreement that they cannot be applied unmodified to small organizations. Many researches were carried out in order to determine what modifications must be made to the model, to make it effective and efficient in these development environments. Tailoring is needed in specific areas, such as documentation, management, review, resources and training. Major improvements can be achieved by improving the technical issues of the process rather than organizational issues,

and proposed a model that integrate CMMI with the ISO 9001 and ISO 9000-3 models.

A proposed model will provide an answer for existing issues like. How can SPI be used to the organization's business goals? How can a software measurement be used effectively within the SPI programmed? How can we assess the effectiveness of the SPI programmed, so that the management can see the return on their investment?

The study pointed out there is fundamental operational differences between small and large organizations the Small organizations are concerned with practice and the large organizations with processes. There are six main key points to software process improvements in small enterprises and they are (ISO/IEC2 2011):

(1) Senior management support

(2) Adequate staffing

(3) Applying project management principles to process improvement

(4) Integration with ISO 9001

(5) Assistance from process improvement consultants

(6) Focus on providing value to projects and to the business

There is study identified seven small organization challenges to follow software

It is quite difficult for any SEs to select an improvement approach, and to apply it in their organization without the external help from the consultants [4]Some of the shortcomings faced by SEs are: Excessive documentation, Extensive number of Specific Practices (SP), Requirement of extensive resources, High training costs, Practices independent of project type, Lack of guidance in satisfying project and development team needs and Many of the smaller companies oppose the CMMI model due to the expensive compliance effort, both in time and money.

The summary of All the above mentioned SPI methodologies are divergent in characteristics; it is required to find out some significant and common attributes so that we can find a comparative view of all the selected approaches. Kautz et al concluded in their findings that primary lesson for the small organizations, which wish to perform improvement activities, is that it makes sense to use a structural model to organize the process. They further suggests the secondary lesson is that the model should be adjusted to the particular conditions of the organizations and the third lesson is that it make sense to perform the improvement activities as a project with clearly assigned and documented roles, responsibilities and resources.

He further pointed out the significance of factors to be studied further like management support and commitment, project planning and organization, education and training, assessment, monitoring and evaluation, staff involvement, support and knowledge transfer by external consultants, usability and validity of the introduced changes and cultural feasibility for process improvement in software small enterprise.

The proposed methodology can be used for future work which is aimed at helping small and medium enterprises to implement and improve their software processes. To help small and medium scale industries, we need to analyze and find the characteristics of these enterprises. To check the software process improvements success factors, we need to determine the software process activities. To improve the software business processes, select the most appropriate software process models that are used in SMEs. Select the most suitable SPI traditional models, Compare these models with the software process models and figure out the missing activities.

2.6. Previous Study About CMMI:

A software development process comprises a group of people, organization structures, rules, politics, activities, software components, methodologies and tools specifically used or created to conceptualize ,develop, serve, extend a software product (Mark) . large number of the organizations that develop software around the world are small in their size. For example, 87% of the companies devoted to software development in Mexico have between 7 and 60 employees (Abbott 1997) (Michael2012-2013). Also There are many studies try to adopting CMMI with in small enterprise easy and efficient, Adopting CMMI for Small Organizations Sponsored by the U.S. Army Aviation and Missile Research, Development & Engineering Center (AMRDEC) Software Engineering Directorate (SED).(Brodman 1995) .

2. 7 Summary:

1. Small Business needs to dovelop their soft ware quickly for the marketing of its products
2. Customer driven requirements are significant (de)motivator
3. Small businesses do not have staff dedicated solely to CMMI implementation customer requirements take priority and can cause delays
4. There is not a lot of functional organization to leverage from in a small business

5. CMMI is easier to interpret for product development than for services Small Businesses are typically more service oriented

6. “The customer rules” Many small organizations adopt/adapt their business practices directly from their customers or primes

By the end of this chapter, we have overview about what software quality from different view or perspectives, the purpose and benefit for using SPI and SPI standard, the most important institutions and organization responsible to develop quality standards for software such as IEEE, ISO and IEC, the most important quality models and overview about CMMI, study about the ability to apply SPI with in Sudanese organization and the problem faced and finally studies that try to solve the problem and propose quality model appropriate with small and medium enterprise.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

I was Distributed 50 form by myself on this companies to ensure greater coverage for avoiding errors to reach truth and accurate results, then I have collecting information from viewpoint of researchers, developers, project managers and each one related to software development process on the institutions target through the basic and traditional model for software development process from collect and analyze data. The questionnaire has been designed to customize CMMI for small software organizations. The result of the questionnaire as shows below :

Almost all of the managers said that in spite of having fewer than 20 staff, and some another fewer than 30 staff so I feel they need of framework which could accomplish their tasks and for continuous improvement processes. Without this framework, the organizations have no uniform method for their activities. Many of them suffered from disorder and their failures are due to this fact. so CMMI necessary to their own organizational structure. Take advantage of the results for previous studies as scientific and real beginning that find out the reasons about, why the software development companies in Sudanese market does not interested to apply the software process improvement and software process improvement standard on the other hands studies try to develop a solution for the current problem. until deliver the software product to find out clear outlines about proposed solution using questionnaire.

3.2 Variables:

The study was include variables divided as Gender Age , professional

scientific specialization (Bsc, Msc, Phd) . , Qualification qualification (Researcher Developer, Project manager) , Years of Experience , and also Contains data on the subject of the study and of the number (45) is covered four Data relating to the subject of study and of a number contains (45) questions covering all the study questions , about some activitiesbasic using from CMMI models .

3.3 Measurement of Variables

the study measure were also measured the degree of potential responses to the paragraphs to Staging a pentathlon as in Likart scale pentathlon (Likart Scale), which ranges from strongly agree to strongly Disagree, as shown table(2) in chapter (4) .

3.4 Data Collection

It means the community college study group of elements that the researcher is seeking to circulate them related to the problem studied the results, have been identified and field study population by restricting individuals with the relationship research topic, whether project developers community managers, analysts and all people who are involved the development of software.

3.5 Sampling

Based on previous studies in this area, but the difficulty of pinpointing the community study was selected study sample vocabulary of a sample (random) which is one of probability samples chosen by the researcher to obtain the views or information from the vocabulary of the community under study, reaching a size of the community (50) individuals, with dont forget to give all the elements a chance to emerge to represent the categories within the target study society. The researcher distributed (50) Astmarha_an the study sample retrieved them (36) form 72% of the total sample is an indication of an initial excellent for the extent of the

respondents interact with the study, but there are a number (4) forms stale and (10) have not been returned, bringing the total valid questionnaires for analysis (36) .
Table (1) in chapter (4).

3.6 Techniques of Data Analysis

The main task of this stage Sort and classify data in the mathematical form and then apply various statistical operations using **SPSS** to get a clear and accurate results that will be compared with the hypothesis and whether it supports or not, percentage and difference between two.

After completion analyzing data we have got clear and accuracy results represent s a summary whole the effort and work that has been done through study and displayed results, determine recommendations for applying software process improvement and software process improvement standards during application development process.

finally, I will try to preview the contribute or any something new can found during the research and how to impact the results for target companies on the quality of their software development process also display shortcomings and limitation on the study and outline about how to be avoided in subsequent studies. I hope very much that the oldest simple scientific contribution in this area and on other hand open door for new questions and new studies. Concluded refine the future work that should be done later.

3.7 Research Design

The questionnaire was distributed to the target companies, this method included some of the activities and practices of the task maturation integrated capabilities that help companies improve software process model. To see if the model was applied or not and design framework is suitable for this companies. The proposed solution will depend on the answers to the developers, researchers, project managers and each one has to do software development.

3.8 Conclusion

By the end of this chapter, covered overview about, main question of this study, questionnaire to collecting information about the assessment of CMMI from viewpoint of researchers, developers, project managers and analyze data and then , prove the question of the study by sending questionnaire to target companies for testing is cmmi applying Sudanese companies and find the suitable framework , and was collected information by questionnaire and give feedback from peoples who deal with software process improvement and their assessment of the this model and then put the solution proposed.

CHAPTER FOUR

RESULTS and DISCUSSIONS

4.1. Results

In this chapter I will discuss data collection and data analytics for questionnaires, this questionnaire was distributed to reach truth and accurate results.

The questionnaire was distributed in real development environments to assess PROPOSED MODEL CMMI (capability Maturity Model Integration) and then collecting data about its efficiency and ability to resolve problems. Questionnaire into groups and categories, each category in a set of questions formulating in a clear, simple and easy to read and understand for respondents, define the relationship between category clearly, include all the ideas that relate to the assessment proposal activity, can also obtain notation or sufficient information when we needed to make some modified for methodology.

People Target by questionnaire project managers, system engineers, designers and developers or all Jobs that are involved in the software development process during all the stages from system analysis to deliver the project.

After completion analyzing data, we have got clear and accuracy results represent a summary for study allow us to determine recommendations and how to applying software quality standards on small and medium enterprises.

This section includes a methodology for conducting the field study includes study design tool, and conducting stability tests and truthfulness of this tool to ensure their validity as well as a description of the community and the study sample, statistical methods by which data were extracted and analyzed the results. and so on as

4.1.1 Data Collection

The first "community and the study sample:

4.1.2 Study Population.

It means the community college study group of elements that the researcher is seeking to circulate them related to the problem studied the results, have been identified and field study population by restricting individuals with the relationship research topic, whether project developers community managers, analysts and all people who are involved the development of software.

4.1.3 Sample

The researcher distributed (50) Astmarha_an the study sample retrieved them (36) form 72% of the total sample is an indication of an initial excellent for the extent of the respondents interact with the study, but there are a number (4) forms stale and (10) have not been returned, bringing the total valid questionnaires for analysis (36) .

Table (4-1) illustrates the questionnaires distributed processing and damaged

Statement	number	Percent
Questionnaires were returned after a full packaged	36	72%
Questionnaires have not been returned	10	20%
Questionnaires Damaged	4	8%
Total distributed questionnaires	50	100%

Second ": study tool

4.1. 4 Questionnaire

A means by which he used a researcher at the necessary data on the phenomenon under study collection, and there are many tools used in the field of scientific research for the information needed to study the data, has adopted the researcher to the questionnaire to collect field data and identify the questionnaire that they (the tool of search tools consist of a set of Vocabulary accompanied by all possible answers to it, or a space to answer when they require a written reply, and to the individual to determine what he sees or applies it in, or believed to be the correct

answer to each item of vocabulary, or to write in a vacuum defined what he believes or he sees or feels as measured towards this vocabulary).[9] Ali Maher's he researcher came to adopt the resolution multiple advantages similar to the following:[13] Ahmed Hussein

1. The potential application to get information on the number of individuals
2. low cost and ease of application
3. easy to put questions and add to their wording and lays her words
4. unmet provide a time and give it a chance to think.
5. To achieve the purpose of the previous questionnaire was designed questionnaire and enclose with it a letter to inform them where respondents were the subject of study and its objective (see Appendix "1") and Form consists of two parts:

Section One:

It includes data on members of the study sample: a description of the personal data on a sampleThe study are:

1.Age

2. Qualification

3. scientific specialization

4. professional qualification

5. Years of Experience

Section Two:

Contains data on the subject of the study and of the number (45) is covered four Data relating to the subject of study and of a number contains (45) is covered four of the hypotheses of the study, the rate of (14), (20), (5), (6) the term of each practices in the one on the level, respectively (2,3,4, 5).

Third ": the Study Measure

Table (4-2) shows the degree to approve a measure

The degree of approval	The relative weight	Percentage	Statistical significance
Strong agree	**5**	**Greater than 80%**	The degree of approval is very high
Agree	**4**	**%80-70**	High degree of approval
Neutral	**3**	**%69-50**	Medium approval
Disagree	**2**	**%49-20**	Low approval
Strong disagree	**1**	**أقل من 20%**	The degree of non- existent approval

Accordingly, the central premise of the study becomes as follows:

Total degree to standard is sum Degrees single on ferries(5+4+3+2+1)/ 5=(15/5) =3) It represents the central premise of the study, And therefore the greater the average phrase from central premise (3) This indicates that the approval of the respondents the phrase, but if the average dropped for phrase central premise (3) Indicates that the non-approval of the respondents the phrase.

Fourth: The evaluation of measurement tools:

4.1.5 Degree of Internal Consistency and Reliability

Scale: all variables

Table (4-3) Case processing summary

	Number	Percent
Valid	36	72.0
Excluded	14	28.0
Total	50	100

Fifth. "Statistical analysis method used in the study:

Table (4-4) Reliability statistics

Alpha	N of items
0.86	45

4.1.6 Analysis Based on Likart Scale: -

The above table display truth and the internal consistency using SPSS program for test the questions and items study, alpha value reached to (0.86) this means the degree of validity and reliability of this study is very high and this enables us to analyze data and get correct and truthful results.

A method of ascribing quantitative value to qualitative data, to make it amenable to statistical analysis. A numerical value is assigned to each potential choice and a mean figure for all the responses is computed at the end of the evaluation or survey. Used mainly in training course evaluations and market surveys, **Likart Scale** usually have five potential choices (strongly agree, agree, neutral, disagree, strongly disagree) but sometimes go up to ten or more as below:

Table (4-5) **Likart Scale**

Value	Weighted average
Strongly agree	From 5.00 to 4.20 T
agree	From 4.19 to 3.40
Neutral	From 3.39 to 2.60
Disagree	From 2.59 to 1.80
Strongly disagree	From 1.79 to 1.00

4.1.7 Descriptive Statistics Methods:

to describe the characteristics of the study sample vocabulary through:

Descriptive statistics to measure the levels of the study

Where are calculation all of the arithmetic mean and standard deviation for each study standards and where is compared arithmetic mean, to standard with the middle premise of the study (3), where approval of the paragraphs materialize if the arithmetic mean is greater than the middle premise of the scale (3), and realized you do not agree if the arithmetic mean less from the middle premise.

Table (4-6) frequency degree distribution

Value	Frequency	Percent
Bsc	19	52.8%
Msc	17	47.2%
Phd	0	0.0%
Other	0	0.0%
Total	36	100.0%

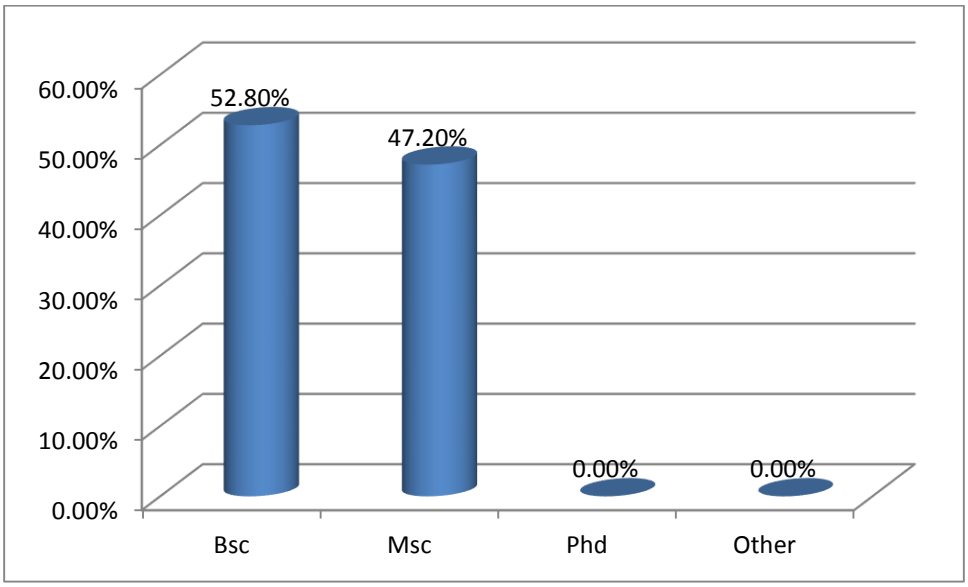

Figure (4-6) degree distribution

Table (4-7) frequency work distribution

Value	Frequency	Percent
Researcher	4	11.1%
Developer	27	75.0%
Project manager	1	2.8%
Other	4	11.1%
Total	36	100.0%

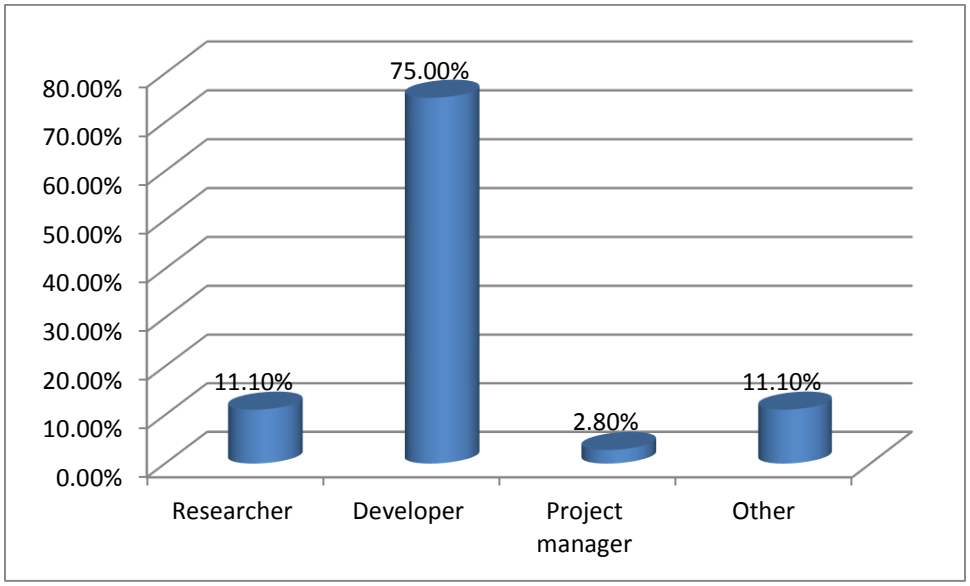

Figure (4-7) work distribution

Table (4-8) frequency experience distribution

Value	Frequency	Percent
2-5 years	27	75.0%
5-10 years	7	19.4%
10-15 years	2	5.6%
More than 15	0	0.0%
Total	36	100.0%

.

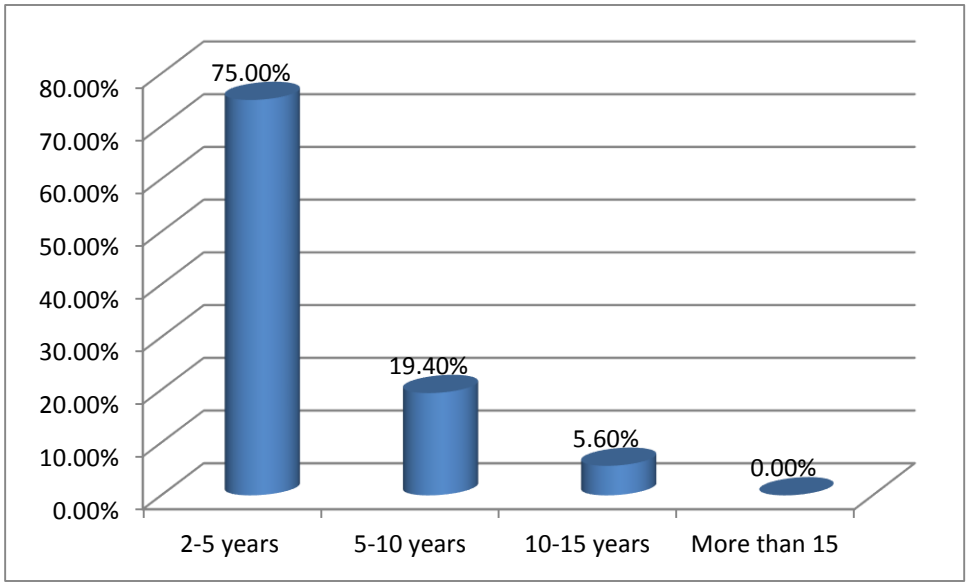

Figure (4-8) experience distribution

Table (4-9) frequency age distribution

Value	Frequency	Percent
Less than 30	28	77.8%
30-40 years	6	16.7%
40-50 years	2	5.6%
More than 50	0	0.0%
Total	36	100.0%

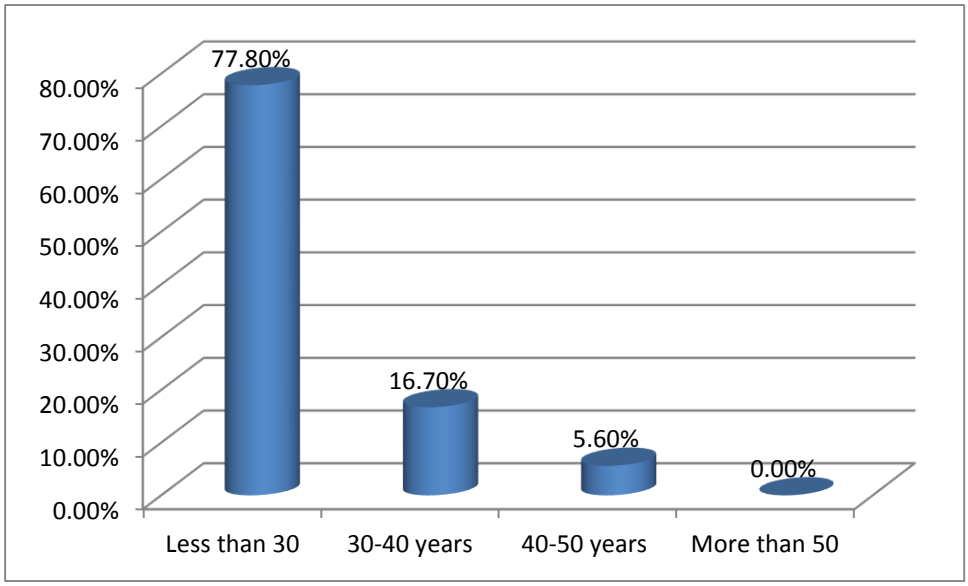

Figure (4-9) age distribution

Table (4-10) frequency gender distribution

Value	Frequency	Percent
Male	29	80.6%
Female	7	19.4%
Total	36	100.0%

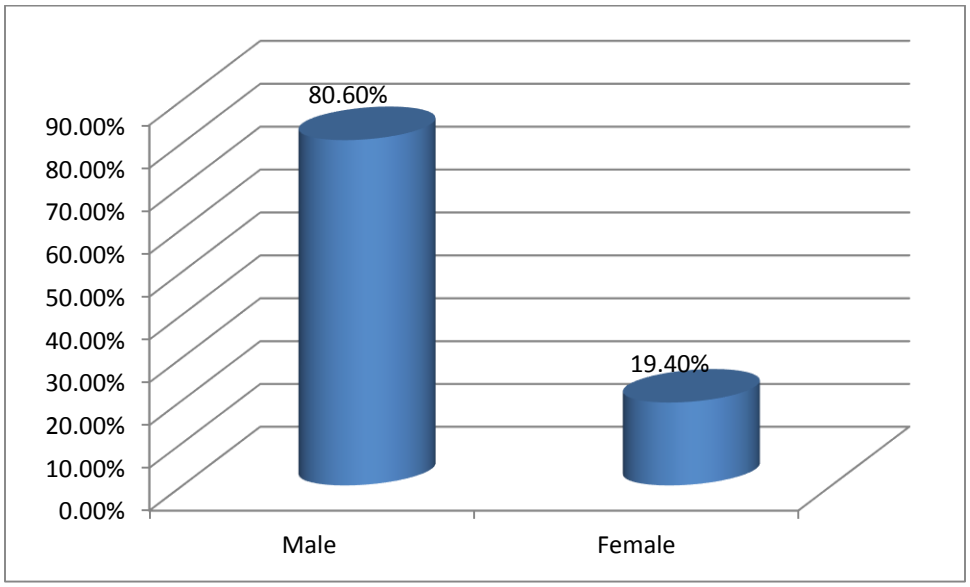

Figure (4-10) gender distribution

Level2 maneged

Variable 1-2:

1- the people in the project who are charged with managing the allocated requirements trained in the procedures for managing allocated requirements

Table NO (4-11)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	5	13.9%
Neutral	3	8.3%
Disagree	12	33.3%
Strongly disagree	14	38.9%
Total	36	100.0%

Variable 2-2:

2- measurements used to determine the status of the activities performed for managing the allocated requirements (e.g., total number of requirements changes that are proposed, open, approved, and incorporated into the baseline)

Table NO (4-12)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	5	13.9%
Neutral	5	13.9%
Disagree	6	16.7%
Strongly disagree	17	47.2%
Total	36	100.0%

Variable 3-2:

3- the project follow a written organizational policy for managing the system requirements allocated to software

Table NO (4-13)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	3	8.3%
Neutral	7	19.4%
Disagree	12	33.3%
Strongly disagree	11	30.6%
Total	36	100.0%

Variable 4-2:

4- estimates (e.g., size, cost, and schedule) documented for use in planning and tracking the software project

Table NO (4-14)

Value	Frequency	Percent
Strongly agree	1	2.8%
Agree	3	8.3%
Neutral	3	8.3%
Disagree	17	47.2%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 5-2:

5- the activities for managing allocated requirements on the project subjected to SQA review

Table NO (4-15)

Value	Frequency	Percent
Strongly agree	1	2.8%
Agree	3	8.3%
Neutral	7	19.4%
Disagree	10	27.8%
Strongly disagree	15	41.7%
Total	36	100.0%

Variable 6-2:

6- measurements used to determine the status of the activities for software tracking and oversight (e.g., total effort expended in performing tracking and oversight activities)

Table NO (4-16)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	4	11.1%
Neutral	9	25.0%
Disagree	9	25.0%
Strongly disagree	11	30.6%
Total	36	100.0%

Variable 7-2:

7- a documented procedure used for selecting subcontractors based on their ability to perform the work

table NO (4-17)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	1	2.8%
Neutral	10	27.8%
Disagree	11	30.6%
Strongly disagree	10	27.8%
Total	36	100.0%

Variable 8-2:

8- changes to subcontracts made with the agreement of both the prime contractor the subcontractor

Table NO(4-18)

Value	Frequency	Percent
Strongly agree	0	0.0%
Agree	3	8.3%
Neutral	10	27.8%
Disagree	6	16.7%
Strongly disagree	17	47.2%
Total	36	100.0%

Variable 9-2:

9- periodic technical interchanges held with subcontractors

Table NO (4-19)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	3	8.3%
Neutral	5	13.9%
Disagree	18	50.0%
Strongly disagree	7	19.4%
Total	36	100.0%

Variable 10-2:

10 the results and performance of the software subcontractor tracked against their commitments

Table NO (4-20)

Value	Frequency	Percent
Strongly agree	6	16.7%
Agree	10	27.8%
Neutral	12	33.3%
Disagree	1	2.8%
Strongly disagree	7	19.4%
Total	36	100.0%

Variable 11-2:

11- the people responsible for managing software subcontracts trained in managing software subcontracts

Table NO (4-21)

Value	Frequency	Percent
Strongly agree	8	22.2%
Agree	6	16.7%
Neutral	9	25.0%
Disagree	2	5.6%
Strongly disagree	11	30.6%
Total	36	100.0%

Variable2 1-2:

12- adequate resources provided for performing SQA activities (e.g., funding and a designated manager who will receive and act on software noncompliance items)

Table NO (4-22)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	4	11.1%
Neutral	5	13.9%
Disagree	6	16.7%
Strongly disagree	17	47.2%
Total	36	100.0%

Variable 31-2:

13- software configuration management activities planned for the project

Table NO (4-23)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	3	8.3%
Neutral	7	19.4%
Disagree	8	22.2%
Strongly disagree	14	38.9%
Total	36	100.0%

Variable 14-2:

14- the project identified, controlled, and made available the software work products through the use of configuration management

Table NO (4-24)

Value	Frequency	Percent
Strongly agree	7	19.4%
Agree	9	25.0%
Neutral	15	41.7%
Disagree	0	0.0%
Strongly disagree	5	13.9%
Total	36	100.0%

Variable 15-2:

15-2 CMMI level2 to apply in small Sudanese enterprise (process areas in this level**)**

Table NO (4-25)

Value	Frequency	Percent
Strongly agree	52	10.3%
Agree	76	15.1%
Neutral	116	23.0%
Disagree	99	19.6%
Strongly disagree	161	31.9%
Total	504	100.0%

Table (4-26)Chi-square test (Chi) Level II

N	Median	Chi-Square	df	Sig	Scale
504	2.0	68.004	4	0.000	Disagree

Table (4-27) illustrates the descriptive statistics first level standards administration

Practices or activities	Std .Deviation	mean	Relative importance	The relative degree	Result Ranking
1- the people in the project who are charged with managing the allocated requirements trained in the procedures for managing allocated requirements	1.21466	**2.1944**	**%52**	Medium	6
2. measurements used to determine the status of the activities performed for managing the allocated requirements (e.g., total number of requirements changes that are proposed, open, approved, and incorporated into the baseline)	1.18322	**2.5000**	**%50**	Medium	8
3. the project follow a written organizational policy for managing the system requirements allocated to software	1.25610	**2.2778**	**%46**	Medium	10
4.estimates (e.g., size, cost, and schedule) documented for use in planning and tracking the software project	1.07312	**1.8611**	**%37**	Medium	11

5. the activities for managing allocated requirements on the project subjected to SQA review	1.02817	**2.1667**	**%43**	Medium	12
6.measurements used to determine the status of the activities for software tracking and oversight (e.g., total effort expended in performing tracking and oversight activities)	1.20679	**2.5278**	**%51**	Medium	7
7.a documented procedure used for selecting subcontractors based on their ability to perform the work	**1.26836**	**2.3611**	**%47**	low	9
8. changes to subcontracts made with the agreement of both the prime contractor and the subcontractor	.98561	**3.3333**	**%67**	Medium	2
9. periodic technical interchanges held with subcontractors	1.02817	**2.8333**	**%57**	Medium	5
10. the results and performance of the software subcontractor tracked against their commitments	1.07312	3.3611	**%67**	Medium	2

11. the people responsible for managing software subcontracts trained in managing software subcontracts	**1.25357**	**3.1667**	**%63**	Medium	3
12. adequate resources provided for performing SQA activities (e.g., funding and a designated manager who will receive and act on software noncompliance items)	**1.20416**	**2.5833**	**%52**	Medium	4
13. software configuration management activities planned for the project	**1.25357**	**2.5000**	**%50**	Medium	5
14. the project identified, controlled, and made available the software work products through the use of configuration management	97060	**3.4722**	**%70**	High	1
Overall average	**1.06891**	**2.6528**	**53%**	Medium	

1.Some activities or practices that reflect the leveI2 (maneged) increase their average of the middls premise (3) This result Indicate on approval sample of individual of these practices of CMMI level2

2. there are three important practices in level II it(Is a documented procedure used forselecting subcontractors based on their ability to perform the work?) (70%) ,(Are changes to subcontracts made with the agreement of both the prime contractor and the subcontractor?)(67%) and(Are the results and performance of the software subcontractor tracked against their commitments?)

(67%) Respectively where reached average reply first practice , the median (3.4722),standard deviation(.97060) , relative importance(70%), Respectively. As for average reply second practice reached the median (3.3333),standard deviation (.98561), relative importance(67%), while average reply third practice , the median (3.3611),standard deviation(1.02817) , relative importance(67%)

3 .less activity of where approved , practice is (Are estimates (e.g., size, cost, and schedule) documented for use in planning and tracking the software project?) where reached the median (1.8611) and standard deviation(1.07312), and the relative importance (37%).

4.reached averaged all practices the General deviation (1.06891) median General(2.6528) ,The relative importance (53%) and this shows that members of the sample agree on some practices second level the and this means that level 2 the the does not apply on small and medium-sized Sudanese companies

Level 3

Variable 1-3:

1- the activities for developing and improving the organization'sand project's software processes coordinated across the Organization (e.g., via a software engineering process group)
Table NO (4-28)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	6	16.7%
Neutral	5	13.9%
Disagree	8	22.2%
Strongly disagree	13	36.1%
Total	36	100.0%

Variable 2-3:

2- your organization's software process assessed periodically
Table NO(4-29)

Value	Frequency	Percent
Strongly agree	8	22.2%
Agree	8	22.2%
Neutral	7	19.4%
Disagree	1	2.8%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 3-3:

3- your organization follow a documented plan for developing
and improving its software process
Table **NO**(4-30)

Value	Frequency	Percent
Strongly agree	5	13.9%
Agree	8	22.2%
Neutral	7	19.4%
Disagree	8	22.2%
Strongly disagree	8	22.2%
Total	36	100.0%

Variable 4-3:

4- senior management sponsor the organization's activities for
software process development and improvements (e.g., byestablishing long-term plans, and by committing resources andfunding)
Table NO(4-31)

Value	Frequency	Percent
Strongly agree	6	16.7%
Agree	8	22.2%
Neutral	15	41.7%
Disagree	3	8.3%
Strongly disagree	4	11.1%
Total	36	100.0%

Variable 5-3:

5- your organization developed, and does it maintain, a standard software process

Table NO(4-32)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	9	25.0%
Neutral	11	30.6%
Disagree	4	11.1%
Strongly disagree	8	22.2%
Total	36	100.0%

Variable 6-3:

6- the organization collect, review, and make available information related to the use of the organization's standard software process (e.g., estimates and actual data on software size, effort, and cost; productivity data; and quality measurements)

Table NO(4-33)

Value	Frequency	Percent
Strongly agree	5	13.9%
Agree	8	22.2%
Neutral	6	16.7%
Disagree	3	8.3%
Strongly disagree	14	38.9%
Total	36	100.0%

Variable 7-3:

7- training provided for developing the skills and knowledge needed to perform software managerial and technical roles

Table NO(4-34)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	12	33.3%
Neutral	9	25.0%
Disagree	4	11.1%
Strongly disagree	8	22.2%
Total	36	100.0%

Variable 8-3:

8- adequate resources provided to implement the organization's training program (e.g., funding, software tools, appropriate training facilities)

Table NO(4-35)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	17	47.2%
Neutral	8	22.2%
Disagree	5	13.9%
Strongly disagree	4	11.1%
Total	36	100.0%

Variable 9-3:

9- measurements used to determine the quality of the training program

Table NO(4-36)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	5	13.9%
Neutral	9	25.0%
Disagree	9	25.0%
Strongly disagree	10	27.8%
Total	36	100.0%

Variable 10-3:

10- the project's defined software process developed by tailoring the organization's standard software process

Table NO(4-37)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	5	13.9%
Neutral	7	19.4%
Disagree	6	16.7%
Strongly disagree	15	41.7%
Total	36	100.0%

Variable 11-3:

11- the project planned and managed in accordance with the project's defined software process

Table NO(4-38)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	6	16.7%
Neutral	4	11.1%
Disagree	10	27.8%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 21-3:

12- the software work products produced according to the project's defined software process

Table NO(4- 39)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	17	47.2%
Neutral	8	22.2%
Disagree	2	5.6%
Strongly disagree	6	16.7%
Total	36	100.0%

Variable3 1-3:

13- the project, do the software engineering group and other Engineering groups collaborate with the customer to establish the system requirements

Table NO(4-40)

Value	Frequency	Percent
Strongly agree	5	13.9%
Agree	14	38.9%
Neutral	10	27.8%
Disagree	5	13.9%
Strongly disagree	2	5.6%
Total	36	100.0%

Variable 41-3:

14- the engineering groups agree to the commitments as represented in the overall project plan

Table NO(4-41)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	12	33.3%
Neutral	9	25.0%
Disagree	2	5.6%
Strongly disagree	11	30.6%
Total	36	100.0%

Variable 51-3:

15- there a written organizational policy that guides the establishment of interdisciplinary engineering teams

Table NO(4-42)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	7	19.4%
Neutral	8	22.2%
Disagree	9	25.0%
Strongly disagree	10	27.8%
Total	36	100.0%

Variable 61-3:

16- the support tools used by different engineering groups enable effective communication and coordination (e.g., compatible word processing systems, database systems, and problem tracking systems)

Table NO(4-43)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	18	50.0%
Neutral	9	25.0%
Disagree	3	8.3%
Strongly disagree	2	5.6%
Total	36	100.0%

Variable 17-3:

17- measures used to determine the status of the intergroup coordination activities (e.g., effort expended by the software engineering group to support other groups)
Table NO(4-44)

Value	Frequency	Percent
Strongly agree	5	13.9%
Agree	5	13.9%
Neutral	10	27.8%
Disagree	4	11.1%
Strongly disagree	12	33.4%
Total	30	100.0%

Variable 18-3:

18- peer reviews planned

Table NO(4-45)

Value	Frequency	Percent
Strongly agree	5	13.9%
Agree	8	22.2%
Neutral	13	36.1%
Disagree	1	2.8%
Strongly disagree	9	25.0%
Total	36	100.0%

Variable 19-3:

19- actions associated with defects that are identified during peer reviews tracked until they are resolved

Table NO(4-46)

Value	Frequency	Percent
Strongly agree	4	11.1%
Agree	4	11.1%
Neutral	12	33.3%
Disagree	4	11.1%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 20-3:

20- participants of peer reviews receive the training required to perform their roles
Table NO (4-47)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	7	19.4%
Neutral	14	38.9%
Disagree	4	11.1%
Strongly disagree	9	25.0%
Total	36	100.0%

Variable 21-3:

21 CMMI levels3 to apply in small Sudanese enterprise(process areas in this level)

Table NO (4-48)

Value	Frequency	Percent
Strongly agree	79	10.9%
Agree	184	25.6%
Neutral	181	25.1%
Disagree	95	13.2%
Strongly disagree	181	25.1%
Total	720	100.0%

Table (4-49)Chi-square test (Chi) Level III

N	Median	Chi-Square	df	Sig	Scale
720	3.00	76.139	4	0.000	Neutral

Table (4-50) illustrates the descriptive statistics level3 standards Defined

Practices or activities	**Std.Deviation**	**MEAN**	Relative importance	The degree of approval	Ranking OF RESULT
1. the activities for developing and improving the organization's and project's software processes coordinated across the organization (e.g., via a software engineering process group)	**1.31747**	**2.5833**	**52%**	Medium	12
2. your organization's software process assessed periodically	**1.21466**	**3.3056**	**66%**	Medium	3
3. your organization follow a documented plan for developing and improving its software process	**1.34754**	**2.8889**	**58%**	Medium	8
4. senior management sponsor the organization's activities for software process development and improvements (e.g., by establishing long-term plans, and by committing resources and funding)	**1.11661**	**3.3056**	**66%**	Medium	3
5. your organization developed, and does it maintain, a standard software process	**1.18288**	**3.0278**	**61%**	Medium	6

6. the organization collect, review, and make available information related to the use of the organization's standard software process (e.g., estimates and actual data on software size ,effort, and cost; productivity data; and quality measurements)	**1.23024**	**2.9722**	**59%**	Medium	7
7. training provided for developing the skills and knowledge needed to perform software managerial and technical roles	**1.15573**	**3.0833**	**62%**	Medium	**5**
8. adequate resources provided to implement the organization's training program (e.g., funding, software tools, appropriate training facilities)	**1.10518**	**3.2500**	**65%**	Medium	4
9. measurements used to determine the quality of the training program	**1.25325**	**2.5278**	**51%**	Medium	13
10. the project's defined software process developed by tailoring the organization's standard software process	**1.17784**	**2.6111**	**52%**	Medium	12
11. the project planned and managed in accordance with the project's defined software process	**1.36248**	**2.5278**	**51%**	Medium	**13**

12. the software work products produced according to the project's defined software process	**1.04198**	**3.3333**	**67%**	Medium	2
13. the project, do the software engineering group and other Engineering groups collaborate with the customer to establish the system requirements	**1.21890**	**3.3333**	**67%**	Medium	2
14. the engineering groups agree to the commitments as represented in the overall project plan	**1.04045**	**3.0556**	**61%**	Medium	6
15. there a written organizational policy that guides the establishment of interdisciplinary engineering teams	**1.20416**	**2.5833**	**52%**	Medium	12
16. the support tools used by different engineering groups enable effective communication and coordination (e.g., compatible word processing systems, database systems, and problem tracking systems)	**1.05522**	**3.4722**	**69%**	Medium	1
17. measures used to determine the status of the inter group coordination activities (e.g., effort expended by the software engineering group to support other groups)	**1.24563**	**2.8611**	**57%**	Medium	9

18. peer reviews planned	**1.06421**	**3.1944**	**63%**	Medium	4
19. actions associated with defects that are identified during peer reviews tracked until they are resolved	**1.10841**	**2.8333**	**56%**	Medium	10
20. participants of peer reviews receive the training required to perform their roles	**.93732**	**2.7500**	**55%**	Medium	11
Overall average	**1.16901**	**2.9749**	**60%**	Medium	

1. Some activities or practices that reflect the leveI3 (defined) increase their average of the meddles premise (3) This result Indicate on approval sample of individual of these practices of CMMI level3

2. there are two important practices in level 3 it (Do the support tools used by different engineering groups enable effective communication and coordination (e.g., compatible word processing systems, database systems, and problem tracking systems)? (69%) , (Are the software work products produced according to the project's defined software process?) (67%) and (On the project, do the software engineering group and other Engineering groups collaborate with the customer to establish the system requirements?) (67%) where reached average reply first practice, the median (3,4722),standard deviation(1.05522) , relative importance(69%), As for average reply second practice reached the median (3.3333),standard deviation (1.04198), relative importance(67%), while average reply third practice , the median (3.3333),standard deviation(1.21890) , relative importance(67%)

3 .less activities of where approved , practice is(Are measurements used to determine the quality of the training program?) and (Is the project planned and managed in accordance with the project's defined software process?)

Respectively , where reached the median (1.07321) and standard deviation(1.8611), and the relative importance (37%) a. As for average reply second practice reached the median (3.3333),standard deviation (1.04198), relative importance(67%),

4.reached averaged all practices the General deviation (1.16901) median General(2.9749) ,The relative importance (60%) and this shows that members of the sample agree on some practices second level the and this means that level 2 the the does not apply on small and medium-sized Sudanese companies

level4

Variable 1-4:

1- the project follow a documented plan for conducting quantitative process management

Table NO(4-51)

Value	Frequency	Percent
Strongly agree	7	19.4%
Agree	7	19.4%
Neutral	12	33.3%
Disagree	0	0.0%
Strongly disagree	10	27.8%
Total	36	100.0%

Variable 2-4:

2-Is the process capability of the organization's standard software process known in quantitative terms?

Table NO(4-51)

Value	Frequency	Percent
Strongly agree	1	2.8%
Agree	8	22.2%
Neutral	13	36.1%
Disagree	2	5.6%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 3-4:

3- adequate resources provided for quantitative process management activities (e.g., funding, software support tools, and organizational measurement program)

As in the following table(52)

Table NO(4-52)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	3	8.3%
Neutral	12	33.3%
Disagree	6	16.7%
Strongly disagree	13	36.1%
Total	36	100.0%

Variable 4-4:

4- the project use measurable and prioritized goals for managing the quality of its software products (e.g., functionality, reliability, maintainability and usability)

Table NO (4-53)

Value	Frequency	Percent
Strongly agree	1	2.8%
Agree	6	16.7%
Neutral	2	5.6%
Disagree	17	47.2%
Strongly disagree	10	27.8%
Total	36	100.0%

Variable 5-4:

5- measurements of quality compared to goals for software product quality to determine if the quality goals are satisfied

Table NO(4-54)

Value	Frequency	Percent
Strongly agree	2	5.6%
Agree	3	8.3%
Neutral	5	13.9%
Disagree	7	19.4%
Strongly disagree	19	52.8%
Total	36	100.0%

6- CMMI level4 to apply in small and medium Sudanese enterprise(process areas in this level)

Table NO(4-55)

Value	Frequency	Percent
Strongly agree	13	7.2%
Agree	27	15.0%
Neutral	44	24.4%
Disagree	32	17.8%
Strongly disagree	64	35.6%
Total	180	100.0%

Table NO (4-56)Chi-square test (Chi) Level II

N	Median	Chi-Square	df	Sig	Scale
180	2.00	40.944	4	0.000	Neutral

Table NO (4-57) illustrates the descriptive statistics level4 standards Q**uantitatively Managed**

Practices or activities	**Std. Deviation**	**Mean**	**Relative importance**	The degree of approval	Ranking OFRESULT
1. the project follow a documented plan for conducting quantitative process management	1.06904	3.3333	66%	Medium	1
2. the process capability of the organization's standard software process known in quantitative terms	.94112	2.8333	57%	Medium	2
3. adequate resources provided for quantitative process management activities (e.g., funding, software support tools, and Organizational measurement program)	1.05522	2.5278	51%	Medium	3

4. the project use measurable and prioritized goals for managing the quality of its software products (e.g., functionality ,reliability, maintainability and usability	1.21760	2.0556	41%	Low	5
5. measurements of quality compared to goals for software product quality to determine if the quality goals are satisfied	1.04198	2.33336	47%	low	4
Overall average	1.06499	2.6167	52%	Medium	

1.Some activities or practices that reflect the leveI4(Q**uantitatively Managed**) increase their average of the middles premise (3) This result Indicate on approval sample of individual of these practices of CMMI level4

2. there is one important practices in level4 it (Does the project follow a documented plan for conductingquantitative process management?) (66%) , where reached average reply first practice , the median (3.3333),standard deviation(1.06904) , relative importance(66%).

3 .less activity of where approved , practice is(Does the project use measurable and prioritized goals formanaging the quality of its software products (e.g., functionality,reliability, maintainability and usability)?) , where reached the median (2.0556) and standard deviation(1.21760), and the relative importance (41%).

4.reached averaged all practices the General deviation (1.06499) median General(2.6167) ,The relative importance (52%) and this shows that members of the sample agree on some practices second level the and this means that level 2 the the does not apply on small and medium-sized Sudanese companies

Level5

Variable 1-5:

1- defect prevention activities planned

Table NO(4-58)

Value	Frequency	Percent
Strongly agree	1	2.8%
Agree	2	5.6%
Neutral	8	22.2%
Disagree	15	41.7%
Strongly disagree	10	27.8%
Total	36	100.0%

Variable 2-5:

2- the project conduct causal analysis meetings to identify common causes of defects

Table NO(4-59)

Value	Frequency	Percent
Strongly agree	0	0.0%
Agree	4	11.1%
Neutral	7	19.4%
Disagree	10	27.8%
Strongly disagree	15	41.7%
Total	36	100.0%

Variable 3-5:

3- the organization follow a plan for managing technology changes

Table NO(4-60)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	3	8.3%
Neutral	11	30.6%
Disagree	7	19.4%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 4-5:

4- new technologies evaluated to determine their effect on quality and productivity
Table NO(4-61)

Value	Frequency	Percent
Strongly agree	3	8.3%
Agree	6	16.7%
Neutral	14	38.9%
Disagree	4	11.1%
Strongly disagree	9	25.0%
Total	36	100.0%

Variable 5-5:

5- the organization follow a documented procedure for incorporating new technologies into the organization's standard Software process
Table NO(4-62)

Value	Frequency	Percent
Strongly agree	5	13.9%
Agree	2	5.6%
Neutral	7	19.4%
Disagree	10	27.8%
Strongly disagree	12	33.3%
Total	36	100.0%

Variable 6-5:

6- training in software process improvement required for both Management and technical staff
Table NO(4-63)

Value	Frequency	Percent
Strongly agree	7	19.4%
Agree	13	36.1%
Neutral	7	19.4%
Disagree	5	13.9%
Strongly disagree	4	11.1%
Total	36	100.0%

7- CMMI levels5 (activates)to apply in small Sudanese enterprise(process areas in this level**)**

Table NO(4-64)

Value	Frequency	Percent
Strongly agree	19	8.8%
Agree	30	13.9%
Neutral	54	25.0%
Disagree	51	23.6%
Strongly disagree	62	28.7%
Total	216	100.0%

Table (4-65)Chi-square test (Chi) Level II

N	Median	Chi-Square	df	Sig	Scale
261	2.00	29.880	4	0.000	Disagree

LEVEL5: Optimizing

Table NO (4-66) illustrates the descriptive statistics level4 standards optimizing

Practices or activities	Std.Deviation	Mean	Relative importance	The relative degree	Ranking OF RESULT
1. defect prevention activities planned	1.08196	2.0278	%41	low	6
2. the project conduct causal analysis meetings to identify common causes of defects	.95077	2.1944	%44	low	5
3. the organization follow a plan for managing technology Changes	1.15745	2.5556	%51	Medium	3
4. new technologies evaluated to determine their effect on quality and productivity	1.09942	2.8611	%57	Medium	2

5. the organization follow documented procedure for incorporating new technologies into the organization's standard Software process	1.32017	2.5000	%50	Medium	4
6. training in software process improvement required for both Management and technical staff	1.28329	3.3056	66%	Medium	1
Overall average	1.14884	2.5741	52%	Medium	

1.Some activities or practices that reflect the level (**Optimizing**) increase their average of the middles premise (3) This result Indicate on approval sample of individual of these practices of CMMI level5

2. there are three important practices in level5 it(Is training in software process improvement required for bothManagement and technical staff) (66%) , where reached average reply first practice , the median (3.3056),standard deviation(1.28329) , relative importance(66%).

3 .less activity of where approved , practice is(Are defect prevention activities planned?) , where reached the median (2.0278) and standard deviation(1.08196), and the relative importance (41%).

4.reached averaged all practices the General deviation (1.14884) median General(2.5741) ,The relative importance (52%) and this shows that members of the sample agree on some practices second level the and this means that level 5 the the does not apply on small and medium-sized Sudanese companies

4.2 Discussions

Almost all of the managers said that in spite of having fewer than 20 staff, and some another fewer than 30 staff so I feel they need of framework which could accomplish their tasks and for continuous improvement processes. Without this framework, the organizations have no uniform method for their activities. Many of them suffered from disorder and their failures are due to this fact. so CMMI necessary to their own organizational structure. The result of this study concluded that the most of the Sudanese software companies do not follow any software process improvement standards , agree with study done by (A. M. Adb-algager 2013) who found The result of study concluded that the most of the Sudanese software companies do not follow any software process improvement. The problem is that not all organizations adopt proven methodologies like CMMI agree with study done by (Glazer, et al., 2008, p. 3). Who found The result of study" The problem is that not all organizations adopt proven methodologies like CMI. There is a perception that CMMI is for large organizations and finally find out what are the difficulties they face in each of these steps and then analyze the data for giving clear outlines . Questionnaire include groups and categories, each category includes a set of clear and simple questions which are easy to read and the understand for respondents, these questions contain sufficient information about using CMMI.

After completion analyzing data, we have got clear and accuracy results represent a summary for study allow us to determine recommendations and how to apply software quality standards (to work customizing for small enterprises) . the questionnaires illustrates distributed processing and damaged in table(1) above Degree of internal consistency and reliability in table(3) above Reliability statistics in table(4) The above table display truth and the internal consistency using SPSS program for test the questions and items study, alpha value reached to (0.86) this means the degree of validity and reliability of this study is very high and this enables us to analyze data and get correct and truthful results .this the organizations seems chaos and does not have a high performance The most common problems when we Implement process the software improvement standard for different kinds of software organizations are: lack of skilled staff who are unable to follow standards, lack of top management support, lack of

customer collaboration, project size/complexity ,Inexperience, resources are not available enough, project Team size and the cost. 35.7% of the respondents believe SPI Model is the most suitable of the software process improvement standards for the different kinds of organizations.
agree with study done by (Aimam 2016)and (A. M. Adb-algager 2013) they found The result of study concluded that these resources are not available in these institutions and there is no sufficient time to train existing staff for software quality standards, because these institutions rely on rapid development and profit for manage their work, on the other hand, customers lack the knowledge of the software quality standards and the importance to apply in their applications , software process improvement standard, definitely that need additional resources and a lot number of experienced and specialists employees in the field of software quality, often these resources are not available in these institutions and there is no sufficient time to train existing staff for software quality standards, because these institutions rely on rapid development

these organizations don't use languages and terminologies of CMMI(there are some roles or groups in both the organization and CMMI but with different names). these organizations is using terminologies different from terminology CMMI- and also there are roles and groups defined in CMMI are not present in the organization.

CHAPTER FIVE

The Proposed Customized Model

5. 1solution Proposal

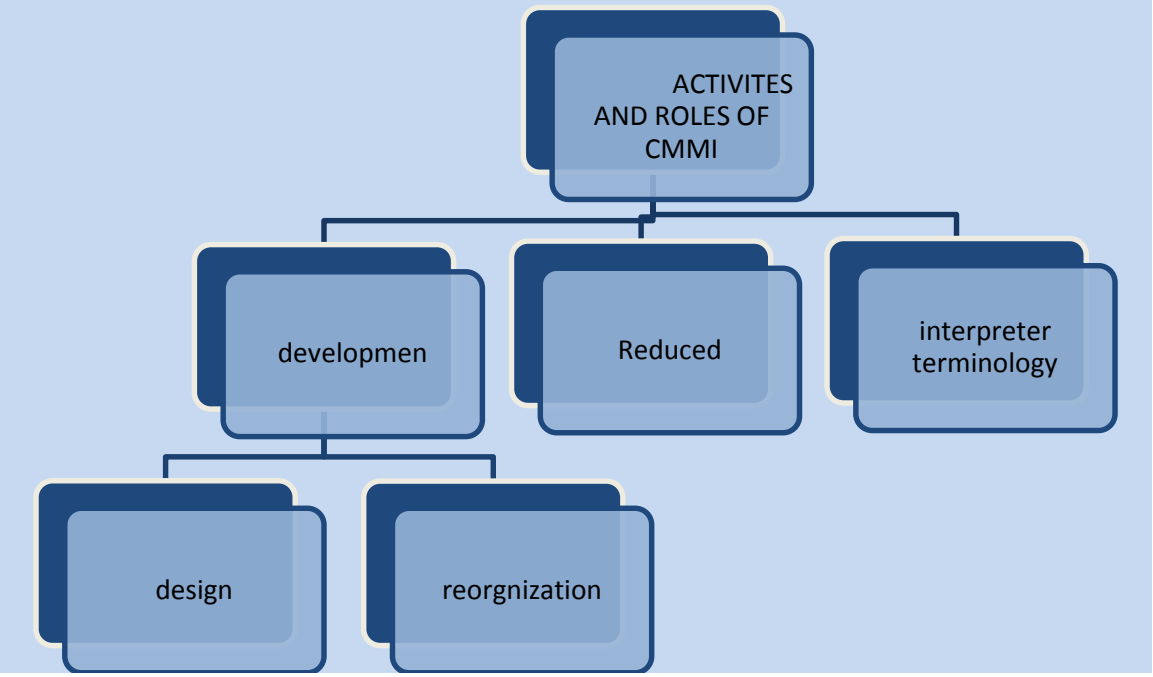

Diagram 5.1 illustrated customize CMMI in small and medium enterprise

5-2 illustrated customize CMMI in small and medium enterprise
To make CMMI applicable to small organizations by three phases is proposed as follows:

1- **interpreted terminology** Stage

in this stage all, the language of the organization must be interpreted to the terminology of CMMI.

2- **reduced roles and** activities stage reduced The number of activities and the effort invested is also decreased in terms of project management

3- **development stage**
At this stage must build the structure of the system and design of a training program

- **Interpreted Terminology Stage**

In this stage, all the language of the organization must be interpreted to the terminology of CMMI. Because there may be some roles or groups in both the organization and CMMI but with different names. roles exist in the organization which are done by a single person or even there may be a group defined in CMMI only consisting of one person mapping to each other through a defined process and document . Activities (customer communication, requirements management and documenting, planning, documenting processes and engineering) must be identified in an organization for an appropriate plan small and medium enterprise because Those activities are found necessary to be done, according to both CMMI and organization's structure and also are necessary for any software organization . Task sequence depends on which task produce deliverables needed in other tasks.

each this activities must be defined at an appropriate level of detail also must be logically ordered to ensure a smooth evolution between tasks, And this tasks may be performed in parallel and sequentially ,Task sequence depends on which task produce deliverables needed in other tasks when critical resources are available or constraints are placed . The appropriate sequence of activities is the outcome. According to the sequence plan and schedule must be establish In this plan each key process area will be seen as a maturity sub-level. After achieving all key process areas of a level, the organization will be considered mature up to it. So, the outcome of this level will be a plan and schedule for implementation , then implementation will start. As mentioned above, key process areas will be done according to the sequence gained by the organization.

- **Reduced Roles And Activities Stage**

At this stage must be reduce The number of activities and the effort invested is also decreased in terms of project management, interpretation and adaptation of Specifics Practices, as follow: (1) reduction of roles: Software Engineer, Software Quality Assurance, Project manager, (2) development of an activity diagram adjusted to small and medium organizations, and (3) design of artifacts or products for each SP analyzed.

- **Development Stage**

At this stage must build the structure of the system and all its components according to prior stapes which are agreed with the CMMI. Include two sub stages, design of a training program and reorganization of roles as follows:

- **Design Stage**

At this stage using the design of a training program , workshop work and
Sending staff to learn to CMMI course, Project Management course, Quality Assurance course, Configuration Management course , Allocate recourses to acquire project management and CMMI tools .

- **Reorganization of Roles**

reorganization of roles. Since human resources are usually limited in small and medium organizations, different people can be involved simultaneously in several projects in a part time basis, by playing multiple roles in the same project. There should be well-defined rules in order to avoid any conflicts due to multiple roles. There are restrictions on SQA roles and members of test teams, for example, the SQA team should be different from that involved in software development.

- **Why Choosing This Stages**

1-the terminology in CMMI is different of organization

2-roles and activities in CMMI are more than software teams in small and medium enterprise

3- reduce roles and activities are needed new restructure appropriate small and medium enterprise ,also the software teams are inexperience .

5-2 Characteristics of This Framework

1-crosess unpredictable poorly controlled reactive

2-process characterized for project and is often reactive

3. processes characterize for the organization (project tailor their processes from organization standards).

4. process measured and controlled .

5. focus on process improvement.

6- simply framework and easy

5-3 About This Framework

-The control levels are the fundamentals levels

-will give us good project management

- drive organizational performance toward higher levels.

5-4Current Model

LEVEL	MAIN FOCUS	ACTIVITIES INVOLVED	QUALITY FACTOR
5: Optimized	Focus on process improvement	•Organizational Innovation • Causal Analysis	HIGH
4: Quantitatively Managed	Process measured and controlled	•Organizational Process Performance •Quantitative Project Management	
3: Defined	Process characterized for the organization and is often proactive	•Requirement Development •Technical Solution •Integration •Verification •Validation •Organizational Training •Risk Management •Decision Analysis and Resolution	
2: Managed	Process characterized for projects and is reactive	•Requirement Management •Project Planning •Project Monitoring •Supplier Agreement Management •Measurement •QA •CM	
1: Initial	Process unpredictable, poorly controlled and reactive		LOW

5-5New Model

LEVEL	MAINFOCUS	ACTIVIETES INVOLEVED
5:Optmized	Focus Process Improvement	Causal Analysis & Resolution
4:Quantitatively Managed	Quantitative Management	Quantitative Project Management
3:Defined	Process Standardization	Requirements Development Technical Solution Organizational Process Definition Integrated Project Management Risk Management
2:Managed	Basic Project Management	Requirements Management Project Planning Project Monitoring & Control Configuration Management
1:Initial	Competent People	

CHAPTER SIX

CONCLUSIONS and RECOMMENDATIONS

6.1 Conclusions

The result of the study showed that companies used the first level from this model and some activities or the practices from other levels, because of inexperience, number of staff is teeny and the tasks base on the developers only. organizations use different terminologies from cmmi terminology and also there are roles and groups defined in cmmi are not present in the organization .

also some roles may exist in the organization but all done by a single person or even there may be a group defined in CMMI only) Inexperience lack of top management support, lack of customer collaboration, project size/complexity, project Team size and the cost , resources are not available enough , CMMI is intended to focus on large projects and organizations and also there are roles and groups defined in CMMI which are not present in the organization ,human resources are usually limited in small organizations, different people can be involved simultaneously in several projects a small , organization does not work with contractors or subcontractors

6.2 Recommendations

The current study was conducted in a vitality area and high degree of importance in the field of software development, discuss problems that facing software industry in the Sudanese market, developed solutions to avoid these problems and reduce the failure of products produced by national institutions and raise the quality of their products to become at the same level large companies that has enough resource to follow software process improvements and software process improvements standards. Attention to products quality of the national companies working in the software development field reflected positively on progress and success and on the other hand supports and bushes the national economy.

The current study concluded many recommendations that must be adhered to by pass to apply software process improvement and software process standards in

small companies in Sudan in particular and the Middle East generally, can be summarized as follows:

1. Ensure success to apply software quality standards in the small enterprises, software standards or project management methodology must be simple, and suit their needs.

2. Providing software quality standards meet small enterprises needs must be merge more than one software quality standard and quality improvement to take advantage of their different characteristics and preferred to be a specialist in a specific development environments.

3. Applying CMMI model on small enterprise meets their needs and enough to improve their software development process maturity.

4.To develop software product with high level of quality must be apply software quality characteristics during product development life cycle and monitor their implementation and put technical recommendations.

5.Provide simple and clear training program during developing projects to qualify staff and improve their skills about how to apply quality standards.
6. Proposed methodology able to solve most of the problems and challenges facing small sized companies, so strongly recommend using in target companies
7. making use of experts foreign ,and some country which used this models for example Egypt .

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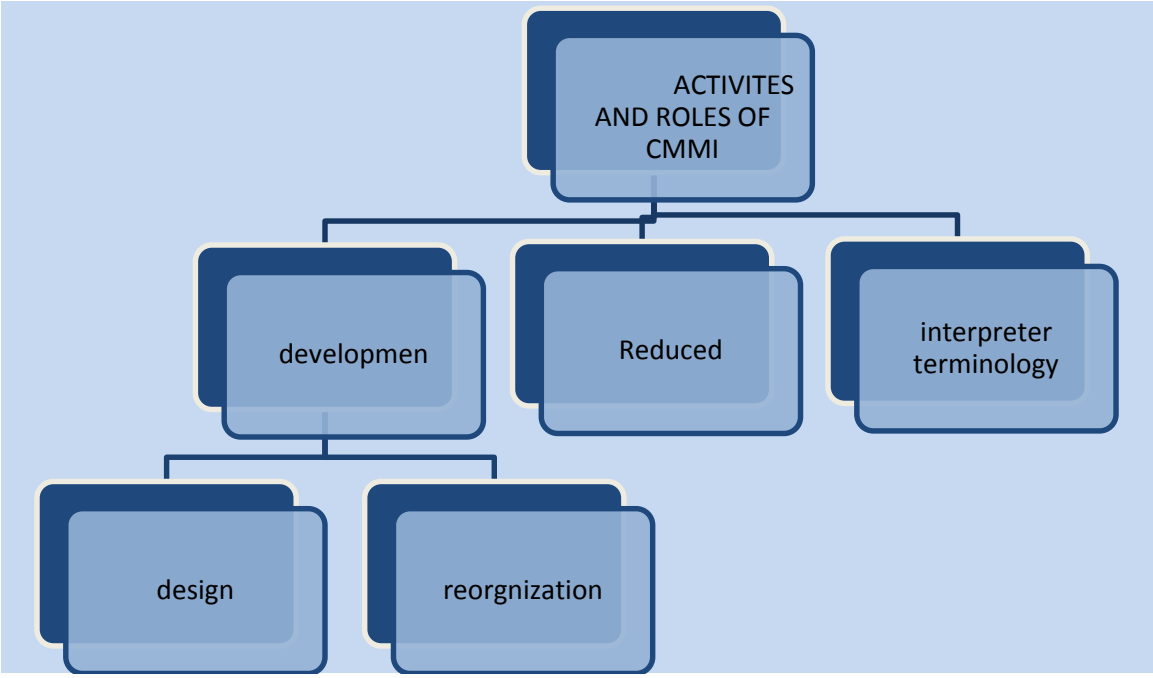
Appendix

Appendix (A) Diagram



Appendix (B) Questionnaire

بسم الله الرحمن الرحيم

إستبيـــــــــــــــــان

الأخ الكريم / الأخت الكريمـــــــــــــة
السلام عليكم و رحمة الله و بركاته
أدعوكم للمشاركة في دراسة أكاديمية لنيل درجة الماجستير في هندسة البرمجيات بعنوان تكيف نموذج نضج القدرات المتكامل علي شركات البرمجة السودانيةأرجو شاكراً الإجابة علي الأسئلة أدناه

البيانات الشخصية

1. الدرجة العلمية ؟
2. بكلاريوس ☐ ماجستير ☐ دكتوراه ☐ غير ذلك ☐

3. طبيعة العمل؟
باحث ☐ مطور ☐ مدير مشروع ☐ غير ذلك ☐

4. سنين الخبرة؟
2- 5 ☐ 5 – 10 ☐ 10 – 15 ☐ 15 فأكثر ☐

5. العمر؟
أقل من 30 ☐ 30 – 40 ☐ 40 – 50 ☐ 50 فأكثر ☐

6. الجنس؟
ذكر ☐ أنثي ☐

Level2:

1. Are the people in the project who are charged with managing the allocated requirements trained in the procedures for managing allocated requirements?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly disagree ☐

2.Are measurements used to determine the status of the activities performed for managing the allocated requirements (e.g., total number of requirements changes that are proposed, open, approved, and incorporated into the baseline)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

3.Does the project follow a written organizational policy for managing the system requirements allocated to software?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

4.Are estimates (e.g., size, cost, and schedule) documented for use in planning and tracking the software project?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

5.Are the activities for managing allocated requirements on the project subjected to SQA review?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

6.Are measurements used to determine the status of the activities for software tracking and oversight (e.g., total effort expended in performing tracking and oversight activities)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

7.Is a documented procedure used for selecting subcontractors based on their ability to perform the work?

Strongly agree ☐ agree ☐ Neutra l Disa ☐ ee Strongly ☐ disagree ☐

8.Are changes to subcontracts made with the agreement of both the prime contractor and the subcontractor?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

9.Are periodic technical interchanges held with subcontractors?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

10.Are the results and performance of the software subcontractor tracked against their commitments?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

11.Are the people responsible for managing software subcontracts trained in managing software subcontracts?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

12.Are adequate resources provided for performing SQA activities (e.g., funding and a designated manager who will receive and act on software noncompliance items)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

13.Are software configuration management activities planned for the project?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

14.Has the project identified, controlled, and made available the software work products through the use of configuration management?

strongly agree ☐ agree ☐ neutral ☐ strongly disagree ☐ disagree ☐

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level 3

1.Are the activities for developing and improving the organization's and project's software processes coordinated across the organization (e.g., via a software engineering process group)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

2.Is your organization's software process assessed periodically?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

3.Does your organization follow a documented plan for developing and improving its software process?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

4.Does senior management sponsor the organization's activities for software process development and improvements (e.g., by establishing long-term plans, and by committing resources and funding)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree ☐ Strongly disagree ☐

5.Has your organization developed, and does it maintain, a standard software process?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

6.Does the organization collect, review, and make available information related to the use of the organization's standard software process (e.g., estimates and actual data on software size, effort, and cost; productivity data; and quality measurements)? .

.Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

7. Is training provided for developing the skills and knowledge needed to perform software managerial and technical roles?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

8.Are adequate resources provided to implement the organization's training program (e.g., funding, software tools, appropriate training facilities)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

9.Are measurements used to determine the quality of the training program?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

10.Was the project's defined software process developed by tailoring the organization's standard software process?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

11.Is the project planned and managed in accordance with the project's defined software process?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

12.Are the software work products produced according to the project's defined software process?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

13.On the project, do the software engineering group and other Engineering groups collaborate with the customer to establish the system requirements?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

14.Do the engineering groups agree to the commitments as represented in the overall project plan?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

15.Is there a written organizational policy that guides the establishment of interdisciplinary engineering teams?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

16.Do the support tools used by different engineering groups enable effective communication and coordination (e.g., compatible word processing systems, database systems, and problem tracking systems)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

17.Are measures used to determine the status of the intergroup coordination activities (e.g., effort expended by the software engineering group to support other groups)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

18.Are peer reviews planned?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

19.Are actions associated with defects that are identified during peer reviews tracked until they are resolved?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

20.Do participants of peer reviews receive the training required to perform their roles?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

level4:

1.Does the project follow a documented plan for conducting quantitative process management?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

2.Is the process capability of the organization's standard software process known in quantitative terms?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

3.Are adequate resources provided for quantitative process

management activities (e.g., funding, software support tools, and organizational measurement program)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

4.Does the project use measurable and prioritized goals for managing the quality of its software products (e.g., functionality, reliability, maintainability and usability)?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

5.Are measurements of quality compared to goals for software product quality to determine if the quality goals are satisfied?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

Level5:

1.Are defect prevention activities planned?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

2.Does the project conduct causal analysis meetings to identify common causes of defects?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

3.Does the organization follow a plan for managing technology changes?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

4.Are new technologies evaluated to determine their effect on quality and productivity?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

5.Does the organization follow a documented procedure for incorporating new technologies into the organization's standard Software process?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

6. Is training in software process improvement required for both Management and technical staff?

Strongly agree ☐ agree ☐ Neutra l ☐ Disagree Strongly ☐ disagree ☐

شكراً جزيلاً علي اهتمامك بالإجابة علي الأسئلة أعلاه والمشاركة برأيكم الكريم .أملي كبير في أن تسهم كل الجهود المبذولة بصورة إيجابية في تحقيق أهداف الدراسة وتقديم حلول فعاله وبسيطة للمشاكل المطروحة.

الباحث : زهراء محمد