PROJECT PLANNING MEASURES IN CMMI

Mahmoud Khraiwesh

Faculty of Science and Information Technology
Zarqa University
Zarqa – Jordan
mahmoud@zu.edu.jo

ABSTRACT

Computer information project planning is one of the most important activities in the modern software development process. Without an objective and realistic plan of software project, the development of software process cannot be managed effectively. This research will identify general measures for the specific goals and its specific practices of Project Planning Process Area in Capability Maturity Model Integration (CMMI). CMMI is developed in USA by Software Engineering Institute (SEI) in Carnegie Mellon University. CMMI is a framework for assessment and improvement of computer information systems. The procedure we used to determine the measures is to apply the Goal Questions Metrics (GQM) approach to the three specific goals and its fourteen specific practices of Project Planning Process Area in CMMI.

KEYWORDS

Monitoring, control, Measures, CMMI, GQM.

1. INTRODUCTION

The purpose of Project Planning stage is to analyze the project in terms of resources, work breakdown, and timing. At the end of this phase the members of the team should be clear on their tasks and project deliverables, responsibilities that are expected from them and the constraints on time they are working.

Increasingly software governs our society and our world, since software becomes common and embedded in nearly every thing we do. We have to make sure that systems run in a better way as we intend. A software project measures is the discipline that ensures that we stay in control. Measurements of a software project apply to products, processes, projects, and people [13].

The Project Planning process elements are cost, resources, and timing. At the end of Project Planning process members of the team should be clear on the sub tasks and with deliverables of the project. In software project plan we define each main task and estimate the time and resources that required completing the tasks [40].

Planning of software projects can be one of the very important activities in the process of modern software development. A realistic and objective software project plan is very important to manage the development of the software project in an effective way [45].

DOI : 10.5121/ijsea.2013.4208

A plan of software project is composed of detailed tasks and stages of activities to be performed, and precedence restrictions among them. The plan of a project is very complex and its construction requires a vast amount of experience and field knowledge [32].

Developing a project plan, which is a critical element of project management, is a difficult process that requires sufficient expertise and experience. Two important success factors that have been examined lately in information system projects are performance of project manager and information system planning maturity [25].

We must spend enough time in planning the project's resources, methods, and milestones and must be ready to replan when requirements, staff, environment, or tools change [18].
Nowadays we know the fact that software measurement helps us to better understand, evaluate, and control the products, processes, and software projects from the perspective of tracking, evaluating, forecasting, controlling and understanding [17]. A good measurement process can supply organizations to make better and more timely decisions to realize success in software systems [26].

Measurement is a valuable support tool for software management [30]. Measurement is the key to effectively manage a process. Measurement is a mechanism for evaluating, characterizing, and predicting for various software products and processes [5]. The effective way to improve any software process is to measure specific attributes of the process, develop a set of related metrics based on these attributes of the process, and then use these metrics to provide indicators that will lead to improvement strategy. Measurement of software plays an important role in understanding and controlling of software development products and processes [29].

Measurement is the process in which numbers or symbols are assigned to attributes of selected entities in the real world in such a way to characterize the attributes by some defined rules [16]. Measurement is important for three main activities: understanding, controlling and improvement [15]. Reasons for measurements are: to assess goals achievement, to determine status according to plans, to gain understanding of processes, products, environments and resources, to establish principles for comparisons with future assessments and follow improvement efforts [36]. The main measurement objective is to monitor the performance of software process [35].

Software measurement is now in a phase in which terminologies, methods and principles are still being defined and combined. We should not look forward to find quantitative laws that are mostly valid and applicable, and have the same accuracy and precisions as the laws of physics, for instance. As a conclusion, the identification of universally valid and applicable measures may be long term and ideal research goal, which cannot be achieved in the closer future, if at all [9]. Software engineering measurements is not grounded in the basic quantitative laws of physics. Direct measurements such as mass, voltage, temperature, or velocity are uncommon in the software engineering world. Because software metrics and measures are often indirect, they are open to controversy [38]. There is a lack of an agreed-upon framework of validation metrics [22]. The goal of software measures is to improve the software process [14].

In the mid-1980s, the Software Engineering Institute (SEI) initiated a study for determining the capabilities of software contractors. The result of this capability assessment was the Software Capability Maturity Model for Software (CMM/SW) [37]. Some other capability maturity models

were followed the CMM software framework, such as the People Capability Maturity Model (P-CMM) [11].

Many organizations from industry, government, and the Software Engineering Institute (SEI) joined together to develop the CMMI software framework, a set of integrated CMMI models.

In United State the Department of Defense and other parts of the government use the Capability Maturity Model Integrated (CMMI) for process improvement to reduce the risk of trivial performance of contractors. The CMMI is a widely used and relatively complete framework for improving the processes of organizations that build complex engineering products [39].

Two kinds of materials are included in the CMMI model [1]:

1. Materials which help you evaluate the contents of your processes, information that is essential for our managerial activities and technical support activities.
2. Materials which help you improve process performance, information that is used to increase the capability in our organizations.

Through the process of adopting CMMI, we try to attain the following objectives: 1- to improve project management capability; 2- to enhance product quality; 3- to increase productivity and cost down; 4- to improve the capability of estimating the project budget and schedule; 5- to increase customer satisfaction [33].

CMMI is a comprehensive model. CMMI covers several topics of knowledge in software production, defined many Process Areas (PA), generic and specific goals, generic and specific practices, and a lot of work products. CMMI is used to improve processes, increase productivity and keep competitiveness of an organization [46].

Within each key process area in CMMI/SW, there are one or more generic goals with generic practices and specific goals with specific practices. A specific goal relates to a process area and focuses on the related characteristics that describe what must be implemented to accept the process area. A specific practice is considered as an important activity in achieving the associated specific goal. However, it is recognized by CMMI that a specific practice is the goal rather than the way that we reach the goal [45].

The Goal-Question-Metric (GQM) method to process and metrics was developed by Basili and Weiss [7] as an approach for identifying meaningful metrics for software development processes. It has proven that it is an effective approach to selecting and implementing metrics.

This paper defines measures for the three specific goals and its fourteen specific practices of Project Planning which is one of the process areas in level 2 in CMMI-SW (Staged Representation) model. Measures will be compatible with the fourteen specific practices associated with the three specific goals of Project Planning PA. The measures will be identified by applying the Goal-Question-Metrics (GQM) approach to the three specific goals and its fourteen specific practices of Project Planning PA. The defined measures will be helpful to us to evaluate and control the software products and processes.

The remainder of the paper is arrange as follows: section 2 describes the relative work in software development measurement for the CMMI/SW, section 3 presents an overview of the CMMI/SW, section 4 presents an overview of the GQM, section 5 describes the application of the GQM to the CMMI/SW and defines the measures, section 6 describes the validity and reliability of the defined measures for Project Planning process area, and section 7 presents conclusions.

2. RELATED WORK

Many software measures studies have been proposed in the literature, some of them are [8] [20] [23] [28] [34] [37]. The most related to our work are [8] [37] [34] and [28]. Baumert and McWhinney [8] provide a set of indicators that are convenient with the measurement practice (a common features) described in the Capability Maturity Model for CMM/SW. These indicators cover thirteen categories, categories don't occur at all of the maturity levels. They don't concentrate on a specific process. Baumert and McWhinney work was related to CMM not CMMI.

Paulk, Weber, Garcia, Crissis and Bush [37] provide a set of examples of measurements in measurement practice (one of the common features) of the Capability Maturity Model for Software (CMM/SW) in Key Process Areas (KPAs). They defined a few examples related to requirements management KPA. They don't focus on a specific process. Their work was based on CMM/SW not CMMI/SW. Loconsole [34] provided measures for the Requirements Management Key Process Area of the CMM/SW. Loconsole's work was based on CMM/SW not CMMI/SW. Khraiwesh [28] provided software measurements for Risk Management PA of the CMMI/SW.

This paper defines a set of general measures that are focused on a specific PA, which is Project Planning PA of the CMMI/SW. Measures are for the three specific goals and its fourteen specific practices of Project Planning PA.

3. OVERVIEW OF THE CMMI-SW

The CMMI/SW (Staged Representation) contains five maturity levels: Initial, Managed, Defined, Quantitatively Managed and Optimizing. The five maturity levels are shown in Figure1. Each maturity level is composed of several process areas except Level1 [41].

For each process area in CMMI/SW, there are generic goals with generic practices and one or more specific goals with specific practices. Generic goals are related to the institutionalization of proper practices, they called generic because the same goal statement appears in multiple process areas as shown in figure 2. The specific goal is applied to the process area and addressed the characteristics that only describe what must be implemented to satisfy the process area. The specific practice is an activity that must be implemented to achieve the associated specific goal [41].

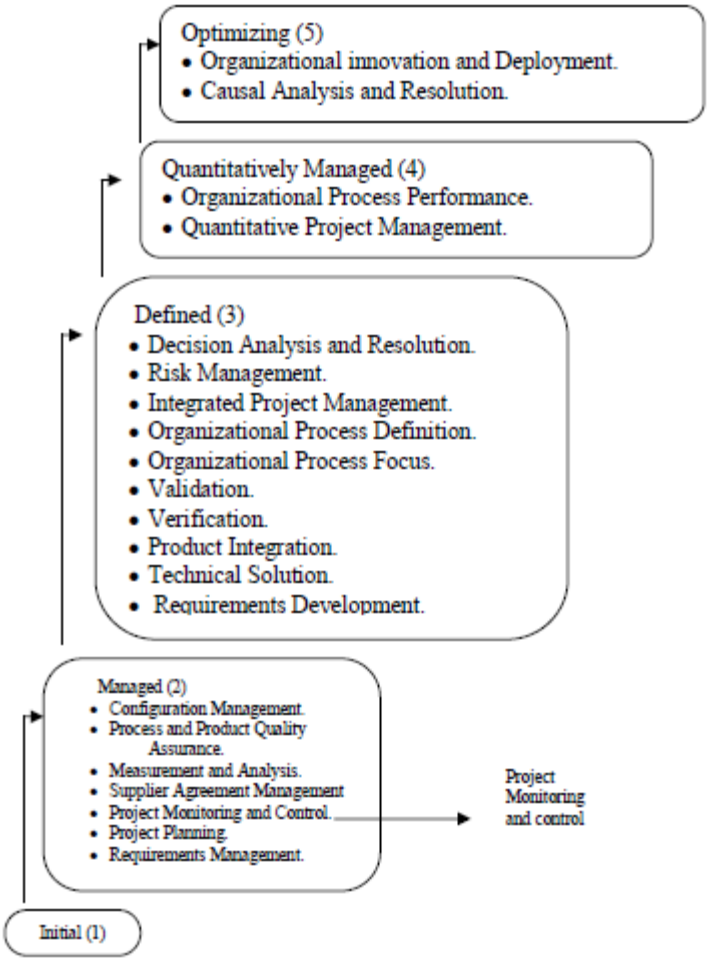

Figure 1. five levels with Process Areas in CMMI.

The purpose of Project Planning (PP) is to identify and maintain plans for controlling project activities. Project Planning includes estimating the attributes of tasks and work products [41].

The following are the specific goals related to Project Planning process area and the specific practices related to each specific goal:

1. Establish Estimates

1.1 Estimate the Scope of the Project
1.2 Establish Estimates of Work Product and Task Attributes
1.3 Define Project Lifecycle Phases
1.4 Estimate Effort and Cost

2. Develop a Project Plan

2.1 Establish the Budget and Schedule

2.2 Identify Project Risks
2.3 Plan Data Management
2.4 Plan the Project's Resources
2.5 Plan Needed Knowledge and Skills
2.6 Plan Stakeholder Involvement
2.7 Establish the Project Plan

3. Obtain Commitment to the Plan

3.1 Review Plans That Affect the Project
3.2 Reconcile Work and Resource Levels
3.3 Obtain Plan Commitment

4. OVERVIEW OF THE GQM

The Goal/Question/Metric (GQM) paradigm is a process that helps an organization to focus the measurement activity on their goals. The GQM states that an organization should have identified goals in mind before data are collected [5]. The more mature your process is, the more that it is visible and therefore measurable. The GQM does not identify concrete goals, it is rather a structure that defines goals and refines them into a set of quantifiable questions, and these questions imply a specific set of measures and collected date in order to realize these goals.

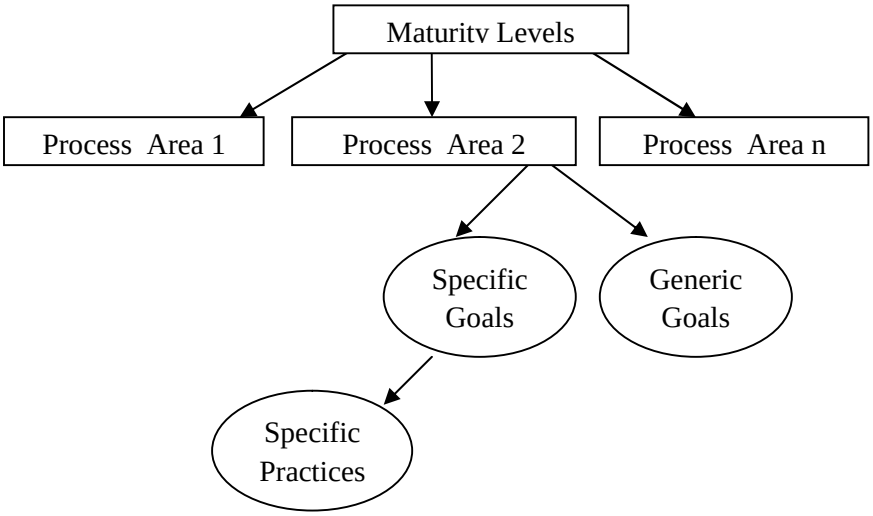

Figure 2. specific and generic goals

The GQM paradigm consists of three steps:

1. Define a set of goals related to the needs of the organization and its projects. Determine what should be learned or improved. The process of goals definition is supported by templates. By using these templates we can define the goals in terms of purpose, perspective, and environment. Measurement goals should be defined in a clear structure and an understandable way. To do this, templates are available to be used the definition of measurement goals by specifying the purpose (what object and why), viewpoint (what aspect and who), and characteristics of context [6].

2. Generate a set of quantifiable questions. The defined goals are transposed into quantifiable questions with a measurement focus. Basili and Rombach [5] provide different sets of guidelines to classify questions related to processes or products.

3. Define a set of measures that provide the quantitative information we need to answer the generated quantifiable questions. In this step, we define the measures suitable to provide information to answer the questions and relate them to each question. Several metrics may be generated from a single goal. Several measurements may be needed to answer one question. One measurement may apply to more than one question.

5. APPLYING GQM TO THE CMMI-SW

The CMMI/SW defines three specific goals for Project Planning PA. There are fourteen specific practices related to the specific goals. We consider the specific practices as goals. We will apply the GQM on the fourteen specific practices.

The fourteen specific practices associated with Project Planning process area are:

1. Estimate the Scope of the Project: Establish a top-level work breakdown structure (WBS) to estimate the scope of the project.
2. Establish Estimates of Work Product and Task Attributes: Establish and maintain estimates of task attributes and work product.
3. Define Project Lifecycle Phases: Define lifecycle phases of the project on which to scope the planning effort.
4. Estimate Effort and Cost: Estimate the effort of the project and cost for the work products and tasks based on estimation rationale.
5. Establish the Budget and Schedule: Establish and maintain the project's budget and schedule.
6. Identify Project Risks: Identify and analyze project risks.
7. Plan Data Management: Plan for the management of project data.
8. Plan the Project's Resources: Plan for resources to perform the project.
9. Plan Needed Knowledge and Skills: Plan for knowledge and skills needed to perform the project.
10. Plan Stakeholder Involvement: Plan the involvement of identified stakeholders.
11. Establish the Project Plan: Establish and maintain the overall project plan.
12. Review Plans That Affect the Project: Review all the plans that relate to the project to understand project commitments.
13. Reconcile Work and Resource Levels: revise the project plan to reconcile available and estimated resources.
14. Obtain Plan Commitment: Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution.

These fourteen specific practices can be used as goals for the first step of the GQM. The second step in the GQM paradigm is to generate a set of quantifiable questions related to the fourteen specific practices. The third step of the GQM is to define a set of measures that provide the necessary quantitative information to answer the generated questions. The typical work products and sub practices which are found in each of the fourteen specific practices are take in consideration when we define the measures.

A set of questions and measures are given in the following tables, table 1 through table14, each table related to one specific practice. There are overlaps between the questions and between the measures. The same measure can be used to provide information to answer different generated questions.

5.1 Measures for specific practice 1.

Estimate the Scope of the Project: Establish a top-level work breakdown structure (WBS) to estimate the scope of the project.
A set of questions and measures are given in the next table concerning specific practice 1.

Table 1. Set of questions and measures concerning practice 1.

	Questions	Measures
Q1	Do you establish a top – level work breakdown structure (WBS) of the project? (A WBS divides the project into a related set of tractable parts called "work packages").	• Eestablishing a top – level work breakdown structure (WBS) of the project. • # Manageable components (work packages). (# means number of)
Q2	Do you define the work packages in sufficient detail so that you can estimate project tasks, responsibilities, and schedule? (Sufficient detail minimizes the need for management reserve).	• Defining the work packages in sufficient detail so that you can estimate project tasks, responsibilities, and schedule. • # work packages with sufficient detail .
Q3	Do you identify risks and their mitigation tasks?	• Identifying risks and their mitigation tasks. • # Risk items.
Q4	Do you identify tasks for deliverables?	• Identifying tasks for deliverables. • # Deliverables.
Q5	Do you identify work products to be reused?	• Identifying work products to be reuse. • # Work products to be reuse.
Q6	Do you identify products and product components to be acquired?	• Identifying products and product components to be acquired. • # Products and product components.

5.2 Measures for specific practice 2.

Establish the Budget and Schedule: Establish and maintain the project's budget and schedule.
A set of questions and measures is given in the next table concerning specific practice 2.

Table 2. Set of questions and measures concerning specific practice 2.

	Questions	Measures
Q1	Do you identify suitable attributes of the work products and tasks to estimate effort, cost, and schedule? Attributes include the following: number of functions, volume of data, number of classes and objects, number of source lines of code, number of database tables , number of fields in database tables, number of architecture elements , experience of project participants , amount of code to be reused , number or risk items , number of subsystems , number of components in each subsystem, geographic spread of project members, nearness of customers, users, and suppliers, the quality of existing code how difficult the customer is.	• Identifying suitable attributes of the work products and tasks. • # records of data. • # functions. • # Source lines of code. • # Classes and objects. • # Database tables. • # Fields in database tables. • # Architecture elements. • # Experience of project participants. • # Amount of code to be reused. • # Risk items. • # Subsystems. • # Components in each subsystem. • # Geographic spread of project members. • Nearness of customers, users, and suppliers. • The quality of code • How difficult the customer is.
Q2	Do you define the top–level strategy for development of the product?	• Defining the top–level strategy for development of the product.
Q3	Do you define the quality attributes expected in the product? Such as safety and security.	• Defining the quality attributes expected in the product.

5.3 Measures for specific practice 3.

Define Project Lifecycle Phases: Define project lifecycle stages on which to scope the planning effort.

A set of questions and measures is given in the next table concerning specific practice 3.

Table 3. Set of questions and measures concerning specific practice 3

	Questions	Measures
Q1	Do you define the project lifecycle phases? (Define the project life cycle is critical in identifying the scope of the project planning).	• Defining the project lifecycle phases. • # Project phases.
Q2	Do you define the project lifecycle depending on the domain of requirements, the nature of the project, and the estimated resources for the project?	• Identifying the project lifecycle depending on the domain of requirements, the nature of the project, and the estimated resources for the project.

Q3	Do you define sub phases for some phases, if needed?	• Identifying sub phases for some phases. • # sub phases.
Q4	Do you select the development models to address the activities in the phases?	• Selecting the development models to address the activities in the phases. • # models to address the activities.

5.4 Measures for specific practice 4.

Estimate Effort and Cost: Estimate the effort of the project and cost for tasks and work products based on assessment rationale.
A set of questions and measures is given in the next table concerning specific practice 4.

Table 4. Set of questions and measures concerning practice 4.

	Questions	Measures
Q1	Do you collect historical data to be used to convert the attributes of tasks and work products into estimates of work hours and cost? (Historical data should include the effort, cost, and schedule data from previous implemented projects).	• Collecting historical data. • # Attributes of work products and tasks from historical data.
Q2	Do you collect models to be used to convert the attributes of tasks and work products into estimates of work hours and cost?	• Collecting of models to estimate labor hours and cost. • # Models.
Q3	Do you include supporting infrastructure needs when estimating effort and cost (in infrastructure include the following: computer resources and engineering tools).	• Including the supporting infrastructure needs when estimating effort and cost. • # Each computer resources. • # Engineering tools.
Q4	Do you identify inputs for estimating effort and cost such as :risks , travel , work breakdown structure , selected project life cycle model , skill levels , training needs , level of security , facilities needed , size estimates of work products and estimates of tasks?	• Identifying inputs for estimating effort and cost.
Q5	Do you identify project effort estimation?	• Identify project effort estimation.
Q6	Do you identify project cost estimation?	• Identifying project cost estimation.

5.5 Measures for specific practice 5.

Evaluate, Categorize, and Prioritize Risks: Categorize and evaluate each identified risk using defined risk group and parameters, and determine its suitable priority.
A set of questions and measures is given in the following table concerning specific practice 5.

Table 5. Set of questions and measures concerning specific practice 5.

	Questions	Measures
Q1	Do you identify major milestones? (milestones are planed points or events in advance, then a review is performed to check that requirements are being met)	• Identifying major milestones. • # Milestones.
Q2	Do you identify schedule assumption? (Assumption is common when schedules are initially developed).	• Identifying schedule assumption.
Q3	Do you identify constraints that limit the flexibility of management?	• Identifying constraints that limit the flexibility of management. • # Constraints.
Q4	Do you identify the optimal tasks order sequence that minimizes the duration?	• Identifying the optimal tasks order sequence.
Q5	Do you establish and maintain the budget and schedule including: resources and facilities, time phasing of activities and schedule activities?	• Establishing and maintain the budget and schedule.
Q6	Do you establish corrective action criteria which can lead to preplanning and revising the original plan?	• Establishing corrective action criteria. • # Criteria.

5.6 Measures for specific practice 6.

Identify Project Risks: Identify and analyze project risks.
A set of questions and measures is given in the next table concerning specific practice 6.

Table 6. Set of questions and measures concerning practice 6.

	Questions	Measures
Q1	Do you identify risks that could negatively affect work efforts and plans?	• Identifying risks that could negatively affect plans and work efforts. • # Risks.
Q2	Do you analyze risks to determine the probability of occurrence, impact, and time in which problems are likely to occur?	• Analyzing risks to determine the probability of occurrence, impact, and time in which problems are likely to occur.
Q3	Do you priorities risks?	• Prioritizing risks.
Q4	Do you use risk identification and analysis tools that can help in identifying possible problems? Examples of tools include: risk taxonomies, check lists, structured interviews, brainstorming, cost models, and quality factor analysis.	• Using risk identification and analysis tools. • # Risk identification and analysis tool.
Q5	Do you review and obtain agreement with relevant stakeholders on the correctness and completeness of documented risks?	• Reviewing and obtain agreement with relevant stakeholders on the correctness and completeness of documented risks. • # Risks.
Q6	Do you revise risk when needed? Examples include the following: when new risks become problem, when new risks are identified and when project circumstances change.	• Revising risk when needed.

5.7 Measures for specific practice 7.

Plan Data Management: Plan for the management of project data.
set of questions and measures is given in the next table concerning specific practice 7.

Table 7. Set of questions and measures concerning specific practice 7.

	Questions	Measures
Q1	Do you determine the project data to be identified and collected? (Data are forms of documentation required to support a project including reports, manuals, drawing and specification).	• Determining the project data to be identified and collected.
Q2	Do you identify data that can be deliverable and non deliverable data?	• Identify data that can be deliverable and non deliverable data. • # Deliverables. • # Non deliverables.
Q3	Do you identify a uniform content and format for data items to facilitate understanding of data content?	• Identifying a uniform content and format for data items.
Q4	Do you establish a procedure to ensure privacy and security of data? (Not every one will access the data).	• Establishing a procedure to ensure privacy and security of data.

5.8 Measures for specific practice 8.

Plan the Project's Resources: Plan for resources to perform the project.
A set of questions and measures is given in the next table concerning specific practice 8.

Table 8. Set of questions and measures concerning specific practice 8.

	Questions	Measures
Q1	Do you define the project resources (e.g., labor, equipment, materials).	• Defining the project resources • # Resources of each kind.
Q2	Do you decompose the top level WBS into work units? (to provide better management control).	• Decomposing the top level WBS into work units.
Q3	Do you determine the process requirements for each activity in the project?	• Determining the process requirements for each activity in the project.
Q4	Do you determine staffing requirements of the project? (skills required for each activity).	• Determining staffing requirements of the project • # Skills required for each activity.
Q5	Do you determine the continuing resource requirements? (electricity, transportation, and intellectual property).	• Determining the continuing resource requirements.

5.9 Measures for specific practice 9.

Plan Needed Knowledge and Skills: Plan for knowledge and skills needed to perform the project.
A set of questions and measures is given in the next table concerning specific practice 9.

Table 9. Set of questions and measures concerning specific practice 9.

	Questions	Measures
Q1	Do you identify the knowledge and skills needed to finish the project?	• Identifying the knowledge and skills needed to finish the project. • # skills.
Q2	Do you assess the available knowledge and skills?	• Assessing the available knowledge and skills.
Q3	Do you select mechanisms for providing needed knowledge and skills? (in - house training, external training, staffing, or external skill acquisition).	• Selecting mechanisms for providing needed knowledge and skills.

5.10 Measures for specific practice 10.

Plan Stakeholder Involvement: Plan the involvement of identified stakeholders.
A set of questions and measures is given in the next table concerning specific practice 10.

Table 10. Set of questions and measures concerning specific practice 10.

	Questions	Measures
Q1	Do you list all relevant stakeholders?	• Listing all relevant stakeholders. • # Relevant stakeholders.
Q2	Do you select carefully the relevant stakeholders for each activity?	• Selecting carefully the relevant stakeholders for each activity.
Q3	Do you identify the responsibilities and roles of relevant participants with respect to project stages?	• Identifying the roles and responsibilities of relevant stakeholders.
Q4	Do you identify the relationships (interaction) between stakeholders?	• Identify the relationships between stakeholders.
Q5	Do you exchange in formation with previous plan of needed knowledge and skills?	• Exchanging information with previous plan of needed knowledge and skills.

5.11 Measures for specific practice 11.

Establish the Project Plan: Establish and maintain the overall project plan.
A set of questions and measures is given in the next table concerning specific practice 11.

Table 11. Set of questions and measures concerning specific practice 11.

	Questions	Measures
Q1	Do you generate an overall project plan that defines all aspects of the effort including: project lifecycle, budgets and schedules, milestones, risk identification, resources, skill requirements, stakeholder identification, and responsibility for project staff?	• Generating an overall project plan that defines all aspects of the effort.

5.12 Measures for specific practice 12.

Review Plans That Affect the Project: Review all plans that affect the project to understand commitments of the project.
A set of questions and measures is given in the next table concerning specific practice 12.

Table 12. Set of questions and measures concerning specific practice 12.

	Questions	Measures
Q1	Do you review all plans that affect the project to ensure that they contain the same common understanding of the scope, objectives, and rules?	• Reviewing all plans that affect the project. • # plans.
Q2	Do you record the reviews of plans that affect the project?	• Recording the reviews of plans that affect the project.

5.13 Measures for specific practice 13.

Reconcile Work and Resource Levels: Adapt the plan of the project to reconcile available and estimated resources.
A set of questions and measures is given in the next table concerning specific practice 13.

Table 13. Set of questions and measures concerning specific practice 13.

	Questions	Measures
Q1	Do you reconcile differences between estimates and available resources?	• Rreconciling differences between estimates and available resources.
Q2	Do you revise requirements list and schedule?	• Revising requirements list and schedule. • # Requirements.
Q3	Do you renegotiate budget?	• Renegotiating budget.
Q4	Do you renegotiate stakeholder agreements?	• Renegotiating stakeholder agreements.

5.14 Measures for specific practice 14.

Obtain Plan Commitment: Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution.
A set of questions and measures is given in the next table concerning specific practice 14.

Table 14. Set of questions and measures concerning specific practice 14.

	Questions	Measures
Q1	Do you negotiate commitments with relevant stakeholders?	• Negotiating commitments with relevant stakeholders.
Q2	Do you use the WBS as a checklist for ensuring that you obtain commitments for all tasks?	• Using the WBS as a checklist for ensuring that you obtain commitments. • # Work packages in WBS.

Q3	Do you document all commitments of the project?	• Documenting all commitments of the project. • # Commitments.
Q4	Do you identify commitments regarding interfaces between the project and other projects?	• Identifying commitments regarding interfaces between the project and other projects. • # Commitments.

6. VALIDITY AND RELIABILITY OF THE DEFINED MEASURES

We have made a questionnaire to examine the validity and reliability of the measures we defined for Project Planning PA and confirm that they are actually measure the fourteen specific practices. We will analyze the collected data by cronbach alpha reliability in SPSS.

The questionnaire was reviewed and confirmed by practitioners in software developing and academics in software engineering in Zarqa University. The questionnaire was filled by software engineers, system designers, and students in computer department. The questionnaire consists of fourteen parts, each part is related to one of the fourteen specific practices of the Project Planning process, each part consists of a group of statements (measures) related to the specific practice, alongside each statement there is five options: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree. The questioner reads the statement then he will write his view of the statement relation with the specific practice by choosing one of the above five options, a sample shown in Appendix A.

Cronbach alpha is used to measure the internal consistency, which means, do all items measure the same thing? (Measure a single unidirectional structure). Values of Cronbach alpha are varying between 0 and 1, if alpha is closer to 1, then there is a greater internal consistency of items being assessed [19]. If Cronbach alpha is less than 0.5 then internal consistencies is rejected [19]. After we apply the collected data on Cronbach Alpha we found alpha results between less than 1 and over 0.5.

7. CONCLUSION

Our paper defined general measures for Project Planning Process Area (PA) in Capability Maturity Model Integration (CMMI-SW) for software development. We defined the measures by applying the Goal Question Metrics (GQM) paradigm to the three specific goals and its fourteen specific practices of Project Planning PA. Our paper focused on defining measures for a specific process area rather than defining measures for many process areas together.

The set of defined measures in the paper provide the organization with better insight into the activities related to Project Planning, enhancing the development of software to the goal of having a matured process. The set of measures can be used to evaluate and control software products and processes. Use of the defined measures depends on the maturity of the software development process in the organization.

REFERENCES

[1] Ahern, D. M., Clouse, A. and Turner, R., CMMI Distilled: A Practical introduction to Integrated Process Improvement. Second edition, Addison – Wesley, 2003.

[2] Alea, M., "Information Technology Outsourcing (ITO) Go-vernance: An Examination of the Outsourcing Management Maturity Model," in Proceedings of the Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04) - Track 8 - Volume 8: IEEE Computer Society, 2004.

[3] Baker, W., Rees, L., and Tiippett, P., Necessary Measures metrice-Driven Information security Risk Assessment and decision making, in communication of the ACM, October 2007, vol.50, No 10.

[4] Baldwin, A., Beres, Y. & Shiu, S., "Using assurance models to aid the risk and governance life cycle" Springer Nether lands, vol. 25, pp. 128-140, Enero 2007.

[5] Basili, V. R. and Rombach, H. D., "The TAME Project: Towards Improvement-Oriented Software Environments", in IEEE Transactions on Software Engineering, vol. 14, no. 6, pp.758-773, 1988.

[6] Basili, V. R., Caldiera, C., Rombach, H. D., Goal Question Metric Paradigm, Encyclopedia of Software Engineering (Marciniak, J.J., editor), volume 1, John Wiley & Sons, pp. 528-532, 1994.

[7] Basili, V. R., and Weiss, D. M., "A Methodology for collecting Valid Software Engineering Data", in IEEE Transactions on Software Engineering, volume. SE-10, pp.728-738, 1984.

[8] Baumert, J. H. and McWhinney, M. S., Software Measures and the Capability Maturity Model, Software Engineering Institute Technical Report, CMU/SEI-92-TR-25, ESC-TR-92-0, 1992.

[9] Briand, L.C., Morasca, S., and Basili, V. R., "An Operational Process for Goal Driven Definition of Measures", in IEEE Transactions on Software Engineering, vol. 28, no. 12, 2002.

[10] Chrissis, M. B., Konrad, M. and Shrum, S., CMMI, USA, Addison Wesley, 2005.

[11] Curtis, B., Hefley, W. E., Miller, S. The People Capability Model : Guidelines for Improving the Workforce. Boston : Addison Wesley, 2001.

[12] Demarco, T., Risk Management for Software Projects, The Atlantic System Guild, Camdem, ME, 2004.

[13] Ebert, C. , Software Measurement for Better Project and Process Quality, UPGRADE (the European Journal for the Informatics Professional), Vol. x, No. 5, October, 2009.

[14] Ejiogu, L. O., " Five Principles for the Formal Validation of Models of Software Metrics ", ACM SIGPLAN Notices, Vol. 28,No. 8, August 1993.

[15] Fenton, N.E., and Pfleeger, S.L., Software Metrics - A Rigorous & Practical Approach, 2nd Edition, International Thomson Publishing, Boston, MA, 1996.

[16] Fenton, N. E. & Whitty, R. and Yoshinori, I. Software Quality Assurance and Measurement, A Worldwide Perspective. London: International Thomson Computer Press, 1995.

[17] Filipe, J., Shishkoy, B., Helfert, M. (Eds.): A Systematic Review Measurement in Software Engineering: State-of-the-Art in Measurement, RICSOFT 2006, CCIS vol. 10, pp. 165–176, 2008. © Springer-Verlag Berlin Heidelberg 2008.

[18] Garcia, S., How Standards Enable Adoption of Project Management Practice, IEEE Software, 22-29, September/October, 2005.

[19] George, D. and Mallery, P., SPSS for windows step by step A Simple Guide and Reference, Fourth Edition, 2003.

[20] Hammer T. F., Huffman L. L., and Rosenberg L. H, "Doing requirements right the first time", in CROSSTALK, The Journal of Defence Software Engineering, December, pp. 20-25, 1998.

[21] Han, W. and Huang, S., An Empirical Analysis of Risks Components and Performance on Software Projects, in the journal of Systems and Software, vol. 80, 2007, pp. 42-50.

[22] Jacquet, J. P. and Abran, A., "Metric Validation Proposals, A structured Analysis", 8th International Workshop on Software Measurement, Germany, Sept. 17-18, 1998.

[23] Janakiram. D and Rajasree. M. S, "ReQuEst: Requirements-driven Quality Estimator", in ACM SIGSOFT Software engineering notes, vol. 30, no.1, 2005.

[24] Jiang, J. and Klein, G., Software Development risks to project effectiveness, in the Journal of Systems and Software, vol. 52, pp. 3-10, 2000.

[25] Jiang , J. J., Klein, G., and shepherd, M., The materiality of Information System Planning Maturity to Project Performance, Journal of the Association for Information System,Vol.2: Iss. 1, Article 5, 2001.

[26] Jones, C. , Implementing a Successful Measurement Program: Tried and True Practices and Tools, Cutter IT Journal, Vol. 11, No. 5, November, 2003.

[27] Kajko, M.and Nyfjord, J., State of Software Risk Management Practice, in International Journal of Computer Science, vol. 35, no.4, 2008.
[28] Khraiwesh, M., Risk Management Measures in CMMI, International Journal of Software Engineering & Applications (IJSEA), Vo. 3, No. 1, 149-163, January 2012.
[29] Kitchenham, B., Pfleeger, S.L., and Fenton, N., Towards a Framework for Software Measurement Validation, in IEEE Transactions on Software Engineering, 21(12), December 1995.
[30] Kitchenham, B. and Jeffery, D., Misleading Metrics and Unsound Analyses, in IEEE Software, April 2007. nstability on Software Defects, in ACM Software engineering notes , 2004, vol. 29, no. 4.
[31] Kumar, R. Managing risks in IT projects: an options perspective, in Information and Management, vol. 40, 2002, pp. 63-74.
[32] Lee, J. K. and Lee, N., Least modification principle for case-based reasoning: a software project planning experience, Expert Systems with application , Volume 30 ,Issue 2, February, 2006 , pages 190-202.
[33] Lee, Y, and Chen, J. Experience in introducing CMM to a telecommunication research organization, Journal of Software Engineering Studies, vol.1, No. 1, 8-16, September 2006.
[34] Loconsole, A., "Measuring the Requirements Management Key Process Area", Proceedings of ESCOM - European Software Control and Metrics Conference, London, UK, April, 2001.
[35] Mahinc, V. and Zabkar, N. Measurement repository for Scrum-based software development process. Conference on computer Engineering and Application (CEA,08) Acapulco, Mexico, January 25-27, 2008.
[36] Park, R. E., Goethert, W. B. and Florac, W. A., Goal-Driven Software Measurement-A Guidebook, Software Engineering Institute Handbook, CMU/SEI-96- HB-002, August, 1996.
[37] Paulk, M. C., Weber, C. V., Garcia, S., Chrissis, M. B., and Bush, M., Key Practices of the Capability Maturity Model Version 1.1, Software Engineering Institute Technical Report, CMU/SEI-93- TR-25 ESC-TR-93-178, Pittsburgh, PA, USA, February, 1993.
[38] Pressman, R. S., Software engineering: A practitioner's Approach, Sixth edition, 2005.
[39] Pyster A., What Beyond CMMI Is needed to Help Assure Program and Project Success, SPW 2005, LNCS 3840, pp. 75 – 82, 2005. © Springer-Verlag Berlin Heidelberg 2005.
[40] Riaz, S. Ahamed, Project Planning : an Analysis, Ahamed International Journal of Engineering Science and Technology, Vol. 2(1), 18-29, 2010.
[41] SEI (software Engineering Institute), CMMI (Capatility Maturity Model-Integrated) for development, V,1.2, Carnegie Mellon University, August 2006.
[42] Sommerville, I., Software engineering, Addison – Wesley, eighth Edition, 2007.
[43] Villalon, J., Agustin, G., Hurtado, G., and Gilabert, T., State of the Art for Risk Management in software Acqnisition, SIGSOFT Software Engineering notes, July 2009, Vol.34, No.4.
[44] Wallace, L. and and Keil, M., Software Project Risks and Their Effect on Outcomes, in the journal of Communications of the ACM , vol. 47, No. 4, pp.68-73, 2004.
[45] Wu, C. S. , Simmons D. B., Software project planning Associate(SPPA): a knowledge based approach for dynamic software project planning and tracking, 24th International Computer Software and Application conference, (COMPSAC), Taiwan, October, 2000.
[46] Young, H., Fang, T., and Hu, C. A successful practice of applying software tools to CMM1 process improvement, Journal of Software Engineering Studies, vol. 1, No. 2, 78-95, December 2006.

Appendix A

Questionnaire and Analysis

Questionnaire**:**
This questionnaire is related to the Project Planning process. Project Planning builds and maintain plans that identify project activities.
The Project Planning process has fourteen goals:
1. Estimate the Scope of the Project. .
2. Establish Estimates of Work Product and Task Attributes.
3. Define Project Lifecycle Phases.
4. Estimate Effort and Cost.
5. Establish the Budget and Schedule.
6. Identify Project Risks.

7. Plan Data Management.
8. Plan the Project's Resources.
9. Plan Needed Knowledge and Skills.
10. Plan Stakeholder Involvement.
11. Establish the Project Plan.
12. Review Plans That Affect the Project.
13. Reconcile Work and Resource Levels.
14. Obtain Plan Commitment.

We would like to measure the accomplishment of the above goals, thus, we define some sentences related to each goal. We suppose that the information in these sentences help us in accomplishment of the above fourteen goals.
Please, fill the enclosed form by writing √ in the suitable place. Responding to this question: do you think that the statements have an effect on the achievement of the goals?

1. Goal1: Estimate the Scope of the Project.
(do you think that these sentences have an effect on the accomplishment of goal1: Estimate the Scope of the Project.)

statement serial	statements	Strongly agree	Agree	Neither agree nor disagree	disagree	Strongly disagree
1	Establishing a top – level work breakdown structure (WBS) of the project.					
2	Defining the work packages in sufficient detail so that you can estimate project tasks, responsibilities, and schedule.					
3	Identifying risks and their mitigation tasks.					

Author

Mahmoud khraiwesh is an associate professor at Faculty of Science and Information Technology in Zarqa University, Jordan. He got his master degree in computer science from Jordan University, Jordan, in 2002 and his doctorate degree in computer information system from The Arab Academy for Banking and Financial sciences, Jordan, in 2006. His area of research is in software development measures.