Global Journal of Information Technology: Emerging Technologies

Volume 8, Issue 3, (2018) 086-094

www.gjit.eu

# Are project managers informally following capability maturity model integration practices for project management?

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**Suggested Citation:**

Iqbal, J., Khan, M. & Minhas, N. M. (2019). Are project managers informally following capability maturity model integration practices for project management? *Global Journal of Information Technology: Emerging Technologies*. *8*(3), 086–094.

Received July 23, 2018; revised October 21, 2018; accepted November 15, 2018;
Selection and peer review under responsibility of Prof. Dr. Dogan Ibrahim, Near East University, Cyprus.


**Abstract**

Project planning is crucial for fruitful completion of a software development project. In case of a certified software development organisation, one can guess whether the software development projects are planned properly or not. But, what to do for a non-certified organisation? The objective of this study is to address this problem. For this purpose, a questionnaire survey has been conducted by involving experienced practitioners. The results show that several software development organisations follow Capability Maturity Model Integration) Project Planning-Process Area practices unofficially. Such organisations are potential candidate organisations for software process improvement initiatives, and would be cheap and safe for successful completion of a project.

**Keywords:** CMMI, software project management, software process improvement, specific goals, specific practices, subpractices.

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## 1. Introduction

Software process improvement (SPI) is an important phenomenon (Babar & Niazi Khan, 2008; Keung & Abdullah-Al-Wadud, 2017; Rahmani, Sami & Khalili, 2016) as organisations attain many benefits through SPI (Miranda et al., 2014; O'Connor & Coleman, 2009). There are many standards for SPI (Babar & Niazi Khan, 2008; Iqbal et al., 2016; Nasir, Ahmad & Hassan, 2008), CMMI-DEV is one of the famous SPI standards (Falessi, Shaw & Mullen, 2014). The number of Process Areas in CMMI-DEV is 22 (Chrissis, Konrad & Shrum, 2011). The classification of CMMI-DEV Process Areas is based on (i) Levels and (ii) Categories (Chrissis et al., 2011). The five maturity levels of CMMI-DEV are: (i) Initial, (ii) Managed, (iii) Defined, (iv) Quantitatively Managed and (v) Optimising (Staples & Niazi, 2010). The four categories for CMMI-DEV Process Areas are: (i) Project Management, (ii) Process Management, (iii) Support and (iv) Engineering (Chen & Staples, 2007; Sivashankar, Kalpana & Jeyakumar, 2010). The 'Project Management' category includes seven Process Areas. Out of seven Process Areas, four are Basic Project Management Process Areas which are: (i) Project Planning (PP), (ii) Project Monitoring and Control (PMC) and (iii) Requirements Management (REQM) and Supplier Agreement Management (SAM). The remaining three Process Areas are called Advanced Project Management Areas which are: (i) Integrated Project Management (IPM), (ii) Quantitative Project Management (QPM) and (iii) Risk Management (RSKM) (Chrissis et al., 2011).

For SPI, Process Areas are targeted (Pino, Baldassarre, Piattini & Visaggio, 2010; Sivashankar, Kalpana & Jeyakumar, 2010). For this purpose, a Process Area's related Specific Goals (SGs) and Generic Goals (GGs) are considered. To achieve the goals, the related Specific Practices (SPs) and Generic Practices (GPs) are implemented. To implement SPs or GPs, the related Subpractices are applied (Chrissis et al., 2011).

This has been observed that in many software development organisations, CMMI project management practices are followed even without formal or official SPI through CMMI. The objective of this study is to investigate whether Project Planning-Process Area related CMMI practices are being informally followed in the software development organisations or not. As mentioned earlier, Project Planning is a Process Area within the Project Management category. The Project Planning-Process Area's aim is creating and maintaining the various plans which are required to define and execute the project related activities (Chrissis et al., 2011). This study explores are CMMI Project Planning-Process Area related practices being followed informally by the project managers in the software development organisations or not? This leads to the following Research Question (RQ):

RQ: Are the project managers informally following Project Planning-Process Area related CMMI practices or not?

We will consider only the SPs related Subpractices for this study. There are three SGs of Project Planning-Process Area whereas 14 SPs and 44 Subpracties are recommended to attain the three SGS.

## 2. Research methodology

To conduct this study, we have employed survey research method as it is considered as a reliable way to gather qualitative or quantitative data (Lethbridge, Sim & Singer, 2005; Niazi, Babar & Verner, 2010). Questionnaire used in this survey contains two parts which consist of closed-ended questions as well as open-ended questions. The first part is to collect demographic information about the participants, whereas in the second part questions have been asked about the informal implementation of the practices associated with Project Planning-Process Area of CMMI.

To conduct survey about unofficial implementation of the CMMI Project Planning-Process Area practices, we contacted to 50 such software development companies which were not CMMI certified. We wanted to involve one such project manager from each company who had at least 10 years overall experience and at least 5 years expertise of project management. Initially, 40 companies showed willingness to participate in the survey. Therefore, questionnaires were sent to 40 project managers

belonging to those 40 companies. Drop-Off/Pick-Up method was employed to deliver questionnaires to the participants and to receive back the questionnaires (Allred & Ross-Davis, 2011; Steele et al., 2001). The filled questionnaires were returned in case of only 25 companies. Out of 25 questionnaires, only 20 (represented by Num) have been chosen for data analysis keeping in view experience and job nature of the respondents.

During the survey, a list of the Subpractices, related to the SPs of CMMI Project Planning-Process Area, was provided to the project managers. The project managers were solicited, in case of each Subpractice, have they been employing this practice informally for project planning or not? If they have been using the practice then what was the percentage of using the practice: (i) in case of less than 50% projects, OR (ii) in case of at least 50% projects. After gathering the data about informal implementation of the Project Planning practices, we have used 50% rule for data analysis.

### *2.1. The 50% rule*

There are 44 Subpractices related to the 14 SPs of the CMMI Project Planning-Process Area. According to the 50% rule, if 22 or more Subpractices/practices are applied by 50% or more project managers in case of 50% or more projects then we can say that Project Planning-Process Areas' practices are implemented unofficially by the project managers for project planning. The analogous criterion that is considering the judgement of at least fifty percent participants for sake of drawing conclusions, has been utilised in several researches (Cox, Niazi & Verner, 2009; Niazi, Wilson & Zowghi, 2005; Rainer & Hall, 2002).

## 3. Results

CMMI Project Planning-Process Area contains three SGs. The SGs have been represented as PPSG1, PPSG2 and PPSG3. The PPSG1 is about establishing estimates for project planning, PPSG2 is regarding the development of the plan for project and PPSG3 is for attaining commitments about the project plan. To achieve PPSG1, there are four SPs. To implement these four SPs, there are 11 Subpractices which are denoted by Subpr1, Subpr2, ... Subpr11.

To achieve PPSG2, there are seven SPs. To implement these seven SPs, there are 26 Subpractices which are denoted by Subpr12, Subpr13, ... Subpr37.

To achieve PPSG3, there are three SPs. To implement these three SPs, there are seven Subpractices which are denoted by Subpr38, Subpr39, … Subpr44. Thus, altogether there are 14 SPs and 44 Subpractices.

Tables 1–3 show the survey results regarding PPSG1, PPSG2 and PPSG3, respectively.

### *3.1. Results related to 1st Specific Goal (PPSG1)*

Table 1 presents 11 Subpractices related to PPSG1 (NP1 = 11), the number of the project managers *Fi* (*i* = 1, 2, … 11) who claim that they have been using a Subpractice and the number of project managers *Gi* (*i* = 1, 2, … 11) who claim that they have been applying the Subpractice in case of at least 50% projects, whereas

$$0 \le \sum_{i=1}^{NP_1} F_i \le \left( NP_1 \, X \, Num \right)$$

and also

$$0 \le \sum_{i=1}^{NP_1} G_i \le \left( NP_1 \, X \, Num \right)$$

**Table 1. Survey results for subpractices related to PPSG1**

| Sr. # | Subpractices ID | Subpractices | Num = 20 | | Num =20 | |
|---|---|---|---|---|---|---|
| | | | $F_i$ | % age | $G_i$ | % age |
| 1 | $SubPr_1$ | Developing the Work Breakdown Structure. | 14 | 70 | 10 | 50 |
| 2 | $SubPr_2$ | Defining the work packages in sufficient detail so that estimates of project tasks, responsibilities, and schedule can be specified. | 12 | 60 | 8 | 40 |
| 3 | $SubPr_3$ | Finding the products and parts of the products which are to be attained externally. | 13 | 65 | 11 | 55 |
| 4 | $SubPr_4$ | Identifying work products to reuse. | 14 | 70 | 6 | 30 |
| 5 | $SubPr_5$ | Determining the technical approach for the project. | 14 | 70 | 12 | 60 |
| 6 | $SubPr_6$ | Using appropriate methods for determining the attributes of the work products and tasks to be used to estimate resource requirements. | 16 | 80 | 13 | 65 |
| 7 | $SubPr_7$ | Assessing the characteristics of work products and tasks | 15 | 75 | 14 | 70 |
| 8 | $SubPr_8$ | Defining Project Lifecycle Phases | 18 | | 16 | 80 |
| 9 | $SubPr_9$ | Collecting models or historical data to be used for transforming the attributes of work products and tasks into estimates of labour hours and costs. | 12 | 60 | 7 | 35 |
| 10 | $SubPr_{10}$ | Adding requirements of supportive infrastructure while assessing effort and cost. | 20 | 100 | 18 | 90 |
| 11 | $SubPr_{11}$ | Assessing required effort and incurring cost based on various models or obtained historic data or blending both approaches. | 18 | 90 | 16 | 80 |

### *3.2. Results related to second specific goal (PPSG2)*

Table 2 presents 26 Subpractices related to PPSG2 (NP2 = 26), the number of the project managers *Hj* (*j* = 1, 2, … 26) who claim that they have been using a Subpractice and the number of project managers *Ij* (*j* = 1, 2, … 26) who claim that they have been applying the Subpractice in case of at least 50% projects, whereas

$$0 \leq \sum_{j=NP_1+1}^{NP_1+NP_2} H_j \leq \left(NP_2 \, X \, Num\right)$$

and also

$$0 \leq \sum_{j=NP_1+1}^{NP_1+NP_2} I_j \leq \left(NP_2 \, X \, Num\right)$$

**Table 2. Survey results for subpractices related to PPSG2**

| Sr. # | Subpractices ID | Subpractices | Num=20 | | Num=20 | |
|---|---|---|---|---|---|---|
| | | | $H_j$ | % age | $I_j$ | % age |
| 1 | $SubPr_{12}$ | Identifying major milestones. | 18 | 90 | 16 | 80 |
| 2 | $SubPr_{13}$ | Identifying schedule assumptions. | 11 | 55 | 7 | 35 |
| 3 | $SubPr_{14}$ | Identifying constraints. | 19 | 95 | 17 | 85 |
| 4 | $SubPr_{15}$ | Identifying task dependencies. | 17 | | 15 | 75 |
| 5 | $SubPr_{16}$ | Establishing and maintaining the budget and schedule | 18 | 90 | 16 | 80 |
| 6 | $SubPr_{17}$ | Establishing corrective action criteria | 2 | 10 | 2 | 10 |
| 7 | $SubPr_{18}$ | Identifying risks. | 18 | 90 | 16 | 80 |
| 8 | $SubPr_{19}$ | Documenting risks. | 19 | 95 | 17 | 85 |
| 9 | $SubPr_{20}$ | Reviewing and obtaining consensus of various stakeholders regarding extensiveness and exactness of the | 17 | 85 | 15 | 75 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | recognised risks. | | | | |
| 10 | $SubPr_{21}$ | Revising risks as appropriate. | 16 | 80 | 14 | 70 |
| 11 | $SubPr_{22}$ | Founding needs and procedures to guarantee data security and privacy. | 13 | 65 | 8 | 40 |
| 12 | $SubPr_{23}$ | Founding the mechanism for archiving data and for accessing archived data. | 5 | 25 | 7 | 35 |
| 13 | $SubPr_{24}$ | Determining the project data to be identified, collected, and distributed. | 12 | 60 | 6 | 30 |
| 14 | $SubPr_{25}$ | Determining the requirements for providing access to and distribution of data to relevant stakeholders. | 11 | 55 | 5 | 25 |
| 15 | $SubPr_{26}$ | Deciding which project data and project plans need version control or other stages of configuration control, and establishing mechanisms to guarantee the controlling of project data. | 13 | 65 | 9 | 45 |
| 16 | $SubPr_{27}$ | Determining process requirements. | 15 | 75 | 13 | 65 |
| 17 | $SubPr_{28}$ | Determining communication requirements. | 16 | 80 | 14 | 70 |
| 18 | $SubPr_{29}$ | Determining staffing requirements. | 15 | | 13 | 65 |
| 19 | $SubPr_{30}$ | Determining facility, equipment, and component requirements. | 16 | 80 | 14 | 70 |
| 20 | $SubPr_{31}$ | Determining other continuing resource requirements. | 15 | 75 | 14 | 70 |
| 21 | $SubPr_{32}$ | Identifying the knowledge and skills needed to perform the project. | 17 | 85 | 16 | 80 |
| 22 | $SubPr_{33}$ | Assessing the knowledge and skills available. | 15 | 75 | 12 | 60 |
| 23 | $SubPr_{34}$ | Selecting mechanisms for providing needed knowledge and skills. | 14 | 70 | 11 | 55 |
| 24 | $SubPr_{35}$ | Incorporating selected mechanisms into the project plan. | 15 | 75 | 10 | 50 |
| 25 | $SubPr_{36}$ | Planning stakeholder involvement | 12 | 60 | 10 | 50 |
| 26 | $SubPr_{37}$ | Establishing the Project Plan | 20 | 100 | 20 | 100 |

### *3.3. Results related to third specific goal (PPSG3)*

Table 3 presents seven Subpractices related to PPSG3 (NP3 = 7), the number of the project managers *Jk* (*k* = 1, 2, … 7) who claim that they have been using a Subpractice and the number of project managers *Lk* (*k* = 1, 2, … 7) who claim that they have been applying the Subpractice in case of at least 50% projects, whereas

$$0 \leq \sum_{k=NP_1+NP_2+1}^{NP_1+NP_2+NP_3} J_k \leq \left(NP_3 \, X \, Num\right)$$

and also

$$0 \leq \sum_{k=NP_1+NP_2+1}^{NP_1+NP_2+NP_3} L_k \leq \left(NP_3 \, X \, Num\right)$$

**Table 3. Survey results for subpractices related to PPSG3**

| Sr. # | Subpractices ID | Subpractices | Num = 20 | | Num = 20 | |
|---|---|---|---|---|---|---|
| | | | $J_k$ | % age | $L_k$ | % age |
| 1 | $SubPr_{38}$ | Reviewing the Plans That Affect the Project | 16 | 80 | 14 | 70 |
| 2 | $SubPr_{39}$ | Reconciling Work and Resource Levels | 15 | 75 | 14 | 70 |
| 3 | $SubPr_{40}$ | Identifying needed support and negotiating commitments with relevant stakeholders. | 17 | 85 | 15 | 75 |
| 4 | $SubPr_{41}$ | Documenting all the obligations of organisation, both full and conditional, confirming the suitable level of signatories. | 14 | 70 | 6 | 30 |
| 5 | $SubPr_{42}$ | Reviewing internal commitments with senior management as appropriate. | 16 | 80 | 14 | 70 |
| 6 | $SubPr_{43}$ | Reviewing external commitments with senior management as appropriate. | 17 | 85 | 15 | 75 |
| 7 | $SubPr_{44}$ | Identifying the commitments about interfaces between project units and other projects, and various units of organisations for monitoring the commitments. | 12 | 60 | 5 | 25 |

## 4. Discussion

For Project Planning-Process Area if in case of at least 50% Subpractices, at least 50% project managers claim that that they have been using or applying these practices informally in case of at least 50% projects then we can say that project managers are informally following CMMI practices for project planning. Therefore, first we are interested in finding the practices that are followed by at least 50% project managers. Second, the practices that are applied in case of at least 50% projects are identified. Then, the practices that fulfil these two conditions must be counted.

### *4.1. Practices followed by at least 50% project mangers*

Data given in Tables 1–3 proves that out of 44 practices only two practices that is $SubPr_{17}$ and $SubPr_{23}$ are followed by less than 50% project managers. These practices are related to PPSG2. All the remaining 42 (95.45% ≈ 95%) practices are followed by at least 50% project managers. The comparison of practices has been shown in Figure 1.

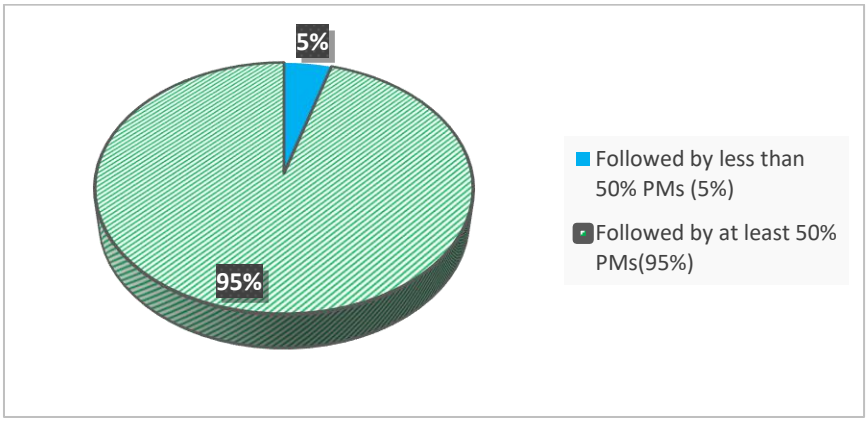


**Fig. 1. Percentage of the practices followed by at least 50% project managers.**

### *4.2. Practices followed in case of at least 50% projects*

Similarly, data from Tables 1–3 indicates that out of 44 practices, the 12 practices are applied in case of less than 50% projects. Out of these 12 practices, three are related to PPSG1, seven belong to

PPSG2, whereas two practices correspond to PPSG3. The 12 practices are $SubPr_2$, $SubPr_4$, $SubPr_9$, $SubPr_{13}$, $SubPr_{17}$, $SubPr_{22}$, $SubPr_{23}$, $SubPr_{24}$, $SubPr_{25}$, $SubPr_{26}$, $SubPr_{41}$ and $SubPr_{44}$. The remaining 32 (72.72% ≈ 73%) practices are followed by project managers in case of at least 50% projects. The comparison of practices has been shown in Figure 2.

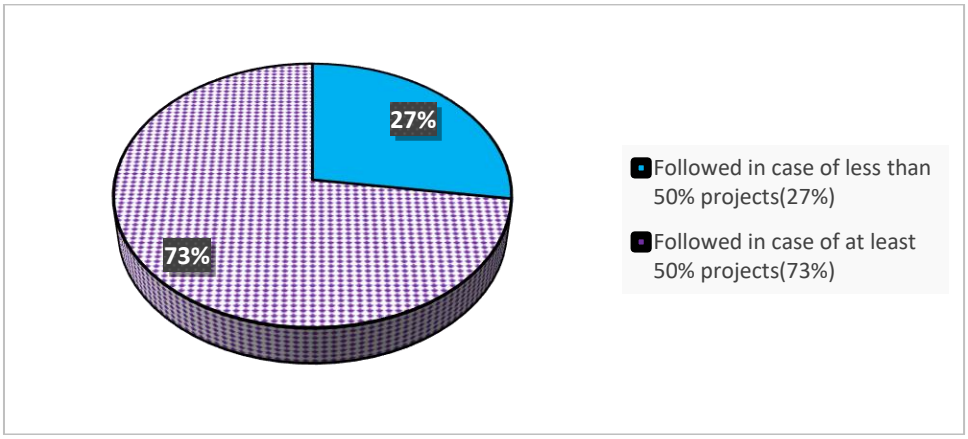


**Fig. 2. Percentage of the practices followed in case of at least 50% projects.**

### *4.3. Practices followed by at least 50% project managers in case of at least 50% projects*

Keeping in view above discussion and data given in Tables 1–3, if we count the practices that are followed by at least 50% project managers for at least 50% projects, such practices are 32. The practices are SubPr1, SubPr3, SubPr5, SubPr6, SubPr7, SubPr8, SubPr10, SubPr11, SubPr12, SubPr14, SubPr15, SubPr16, SubPr18, SubPr19, SubPr20, SubPr21, SubPr27, SubPr28, SubPr29, SubPr30, SubPr31, SubPr32, SubPr33, SubPr34, SubPr35, SubPr36, SubPr37, SubPr38, SubPr39, SubPr40, SubPr42 and SubPr43. These 32 practices have been highlighted in Tables 1–3. Now, this is evident that out of total 44 practices for 32 practices, that is 73% practices, at least 50% project managers claim that that they apply these practices in case of at least 50% projects. The comparison of the practices has been shown in Figure 3.

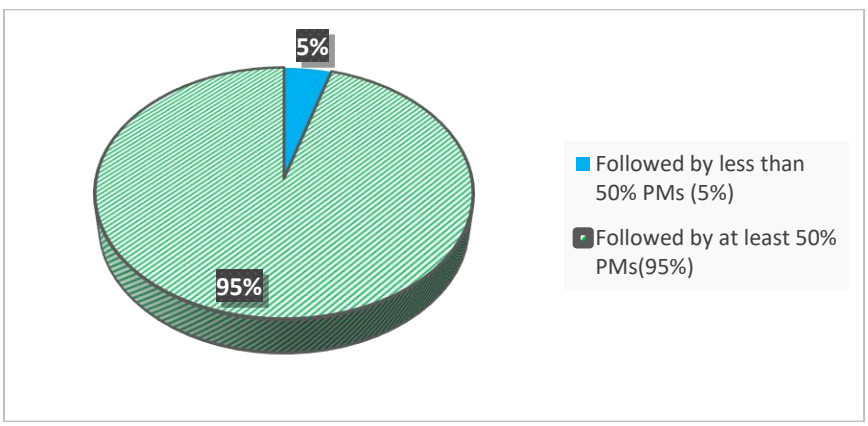


**Fig. 3. No. of practices followed by at least 50% project managers in case of at least 50% projects.**

As basic criterion has been fulfilled, therefore, we can say that project managers are following Project Planning-Process Area related CMMI practices informally. This answers to RQ1. From these results, this can also be inferred that project managers apply CMMI practices for project management unofficially.

This survey has been demonstrated that in some software development organisations, CMMI practices are followed for project management even without attaining official CMMI certification. For this study, we have employed 20 project managers from 20 companies, one form each company. This survey has been performed for Project Planning-Process Area. Similar investigations can be conducted for other Process Areas of the 'Project Management' category. So if in case of a particular company or project manager, at least 50% practices are followed for at least 50% projects then such company or organisation will be a potential candidate for SPI initiatives taken by the relevant authorities. Furthermore, such organisation is likely to safer (because of following CMMI practices) and cheaper (because of not being CMMI certified officially) to get software developed.

## 5. Conclusion

Many software development organisations use CMMI practices for project management although they are not CMMI certified officially. To investigate this trend, a questionnaire survey has been conducted about the informal implementation of the CMMI Project Planning-Process Area's practices. The 20 project managers from 20 non-CMMI certified organisation, having at least 5-year experience of project management, have participated in the survey. By providing a list of the 44 Subpractices related to the three Specific Goals of the Project Planning-Process Area, the project managers have been solicited in case of each Subpractice whether they have been applying this practice or not? If they have been using the practice then what was the percentage of using the practice: (i) for less than 50% projects OR (ii) for at least 50% projects. The 50% rule has been employed to analyse the data. The results prove that 73% Project Planning related practices are followed by at least 50% project managers in case of at least 50% projects. This proves that CMMI Project Planning related practices, and hence the project management practices, are used by software development organisations unofficially.

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