Journal of Computer Science

Original Research Paper

CMMI V2.0 Maturity Level 2 and Scrum Applicability in Jordanian Agile Companies Based on Expert Review

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Article history
Received: 23-11-2023
Revised: 09-01-2024
Accepted: 19-01-2024

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Abstract: It is essential for companies to employ the CMMI V2.0 practice areas to achieve their objectives. This study explores the extent to which these practice areas are applied by Jordanian Agile Companies (JAC) as there is a lack of studies that conducted in the field. Three steps were performed to get the study's results: Designing the questionnaire, data collection and analysis, and finally, calculating the degree of support. The degree of support for each practice is obtained using a mean interval and then the overall average of support for the relative Practice Area (PA) is calculated. The results show that among ten practice areas, eight practice areas related to Maturity Level 2 (ML 2) are applicable by JAC. However, four practice areas are partially applicable to JAC. The findings of this study are fruitful to be used by JAC to get a high maturity level and achieve the planned business objectives.

Keywords: CMMI, Scrum, Practice Area, JAC

Introduction

Software Process Improvement (SPI) models are very important for companies to support their processes and increase software quality. One of the most well-known and common (SPI) models is the Capability Maturity Model Integration (CMMI) (Pikkarainen, 2008; Alshammari and Ahmad, 2010; Husni *et al*., 2018). CMMI has become essential to all aspects of the software industry and it is very important for companies to attain high-quality software (Henriquez *et al*., 2021). CMMI V2.0, published in 2018, was developed to be reasonable, flexible, and appropriate to agile development methods such as Scrum (Henriquez *et al*., 2021). This model proposes detailed directions to guide organizations using agile practices (particularly Scrum) to improve their processes and emphasize performance (Henriquez *et al*., 2021).

The Agile Report published in 2020 mentions that around 95% of targeted companies use agile practices in general (Digita.ai, 2020). One of the most common agile development methods that focus on management practices is Scrum (Henriquez *et al*., 2021; Altarawneh, 2016).

This study covers the verification procedure to confirm that Scrum and CMMI V2.0 ML 2 are compatible. In order to verify that, the primary CMMI practice areas included in ML 2 are mapped with the Scrum method, using expert review.

CMMi V2.0

The CMMI model is a collection of best practices arranged by essential business capabilities that enhance company performance (CMMI, 2020). A CMMI assessment looks at how well an organization's processes adhere to CMMI best practices and their strengths and shortcomings. It offers a dependable, constant, clear, and actionable emphasis on performance that will lead to a considerable influence on the corporation and aid in enhancing capability (Henriquez *et al*., 2021; Jedrzejowska, 2022).

Organizations can discover and rank business development initiatives using this model. Customers and business partners can also see a depth of quality and professionalism by using a benchmark maturity level or competence level attainment (Jedrzejowska, 2022).

The following elements comprise the model architecture (Jedrzejowska, 2022; CMMI, 2020): Capability areas can be logically grouped into categories for capacity areas. A Capacity Area (CA) is a group of practice areas. Practice Area (PA) is a collection of practices that describes a crucial task required to realize a company's value. A Practice Group (PG) is a logical collection of practices with the same level of capability. Practices are the most elaborated level of the model. It outlines the business value that its objective will attain. CMMI V2.0 has five maturity levels that derive the practices in Fig. 1. Level 0 and level 1 processes are still reactive, uncontrollable, and unpredictable, which raises

the risk of inefficiency that can be achieved by most organizations that use standard development methods like Scrum. In level 2 projects define processes, which are typically reactive. Processes in level 3 are well-defined and comprehended. Level 4 ensures that processes are monitored and managed based on standard measurements. Quantitative data is being used by the company to establish reliable processes that satisfy its objectives. The organization follows standard guidelines and is more proactive than reactive. The organization that reaches level 5 should focus on adapting to changes and making continuous improvements. The processes at that level are both adaptable and stable.

This study focuses on the PAs that belong to the second maturity level ML 2 as it is considered a starting point for the organization to improve their development process.

Scrum

Agile development methods may be used with CMMI since they are designed to overcome the drawbacks of conventional development methods, including those related to flexibility, cost, and team size. (Edison *et al*., 2021; Husni *et al*., 2018; Gaborov *et al*., 2021). Scrum is the most common agile project management methodology that aids teams in organizing and controlling their work through a set of values, principles, and practices (Digita.ai, 2020; Gaborov *et al*., 2021). Scrum enables teams to self-organize while working on a problem, learn from experiences, and reflect on their successes and failures to keep improving (Digita.ai, 2020). Scrum is selected in this study as a baseline since JAC developers consider it to be the most popular agile method and it provides a set of practices that might facilitate the use of CMMI V2.0.

Numerous studies have been carried out to address how to use CMMI practices with development methods. This section discusses the most recent and common to this study. Bougroun *et al*. (2014) illustrate how Scrum, XP, and Kanban are mapped to the process areas of CMMI maturity level 3. As these three agile approaches complement each other, this study found that their practices fulfill a significant number of CMMI maturity level 3 goals. The other process areas in the other CMMI maturity levels were not taken into consideration.

Research has been done by Farid *et al*. (2016) to examine how Scrum practices and assets may be used to achieve CMMI V1.3 specific practices in the Project Management category. The results show that Scrum can fulfill most of CMMI V1.3 levels 2 and three. However, it needs to be improved to overcome CMMI V1.3 levels 4 and 5. A theoretical investigation between Agile approaches (XP and Scrum) and CMMI-specific and general goals at maturity level 3 was carried out by Torrecilla-Salinas *et al*. (2014). They exclusively took Web development environments into account. The study is considered a theoretical gap analysis because it was not validated.

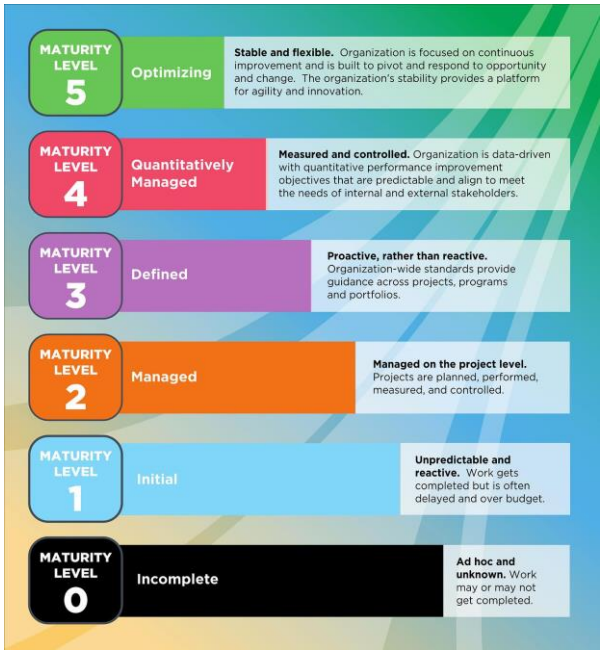

Fig. 1: CMMI maturity levels adopted from (Nanayakkara, 2021)

Sreenivasan and Kothandaraman (2019) carried out research that focused on the use of Scaled Agile Framework (SAFe) and CMMI V2.0. The study illustrates the alignment between CMMI V2.0 and SAFe; however, it does not explain how SAFe artifacts perform the Practice Areas of CMMI V2.0. Using document content analysis, the study conducted by Henriquez *et al*. (2022) illustrates how agile in general and CMMI V2.0 are aligned. Nevertheless, the authors provide no industry validation or case studies to support their work.

In addition, most agile companies are seen as being of small size with a limited budget and the most common agile method used by JAC is scrum (Tarawneh *et al*., 2019; Altarawneh, 2016).

These studies clearly show that there is a lack of studies done on the practices of CMMI V2.0 and Scrum in Jordan to date. For this reason, it's critical to verify that Scrum and CMMI V2.0 ML2 practices are applicable in JAC.

Materials and Methods

This study explains the verification process that examines the applicability of CMMI v2.0 ML 2 and the Scrum method based on expert review. The benefits of applying expert review include its utility in researching a small number of cases and its considerable value in obtaining opinions from practitioners about a theory that has been suggested in the field (Almomani *et al*., 2020; Blaxter *et al*., 2001; Idros *et al*., 2020). The main objective of the verification process is to confirm that

practices of CMMI V2.0 which belong to ML 2 are applicable to be used by JAC that uses Scrum. Three steps were completed to get the findings for this study: Designing the questionnaire, data collecting and analysis, and calculating the degree of support.

Designing the Questionnaire

The questionnaire is created based on CMMI V.2.0 ML 2 practices. Each practice represents a question. Each question has three possible answers ranging from (1-3) 1 not supported, 2 partially supported, and 3 supported to rank the applicability of the practice by the selected developers. The applicability means the practice is clear, simple, and easy to use by the organization (Himayat and Ahmad, 2023; Luburić *et al*., 2018). The respondents of this study are the developers of Jordanian companies with more than five years of experience in using agile methodologies spatially Scrum.

Data Collection and Analysis

More than twenty developers from JAC were chosen based on their experience at random to participate in this survey as responders. Jordan was chosen as the subject of this research due to its unique organizational characteristics. Most of JAC is situated in Amman. The author was obliged to meet the expert in person while they answered the questionnaire since the response rate was initially poor. Only nine developers finished the questionnaire which considered an acceptable number of experts to complete the process of verification (Altarawneh, 2016; Almomani *et al*., 2020; Idros *et al*., 2020). Furthermore, Hallowell and Gambatese (2010) demonstrated that between three and eight experts needed to participate in the verification process. The experts who did either didn't finish it or didn't have responses that were reasonable given their experience levels. The questionnaire was formulated in a Google form and distributed to the experts through email and WhatsApp. The analysis is started after data collection.

Calculating the Degree of Support

At this step, the practice mean is calculated to figure out its degree of support. As a standard scale to be followed for these types of studies, three Likert scales are used to determine the degree of support (Paulk, 2001; Omran, 2008; Husni *et al*., 2018). The application of the practices is determined by the calculating mean and then specifying the appropriate interval that represents the mean value. The interval was calculated as in Eq. 1:

$$Interval = (scale - 1) / scales \quad (1)$$

Table 1: Interval representations for degree of support

Interval	Degree of Support	Color
From 1-1.67	Not supported (N)	Red
From 1.68-2.35	Partially supported (P)	Yellow
From 2.36-3.00	Supported (S)	Green

The interval for the study = (2/3) = 0.67. Table 1 shows the intervals and their representations of the degree of support. Several studies, including Ali *et al*. (2011); and Bidad and Campiseño (2010), recommended this interval calculation.

Results and Discussion

The results of this study are separated into two parts: respondent demographic and practice areas applicability.

Respondent Demographic

Respondents were questioned on their experience and position in this part. The distribution of respondents' positions and years of work experience in their businesses is shown in Table 2. Cross-tabulation was used to present the data.

The findings indicated that most respondents are team members, with 56% having five to ten years of experience. The product owner comes next with 22% having more than five years of experience. Lastly, with over 10 years of expertise, just one responder is a Scrum master.

Practice Areas Applicability

This part shows the practice areas' applicability. CMMI V2.0 ML 2 includes ten practice areas which will be the main subject of this study. Based on the calculation of the Degree of Support (DS), Overall Average (OV), and Overall degree of Support (OS), the findings are presented. each practice in every PA has a mean value. The degree of support is determined by comparing the mean value with the appropriate interval value in Table 1. The mean value and degree of support for each of the chosen practice areas are presented in Table 2 through Table 11.

SAM is concerned with increasing the success of agreed-upon efforts to provide a supplier deliverable by creating a clear understanding between the acquirer and supplier (Jedrzejowska, 2022). Table 3 shows how the SAM is being used to some extent by the JAC developers. Therefore, JAC should assist the SAM by working more to put its related practices into effect.

CM uses configuration identification, control, and auditing to develop and maintain the integrity of work products (Jedrzejowska, 2022). The results shown in Table 4 illustrate that all practices in the configuration management PA are partially applicable to JAC.

Table 2: Respondent demographic

Job position		Experience: Less than 5 years	5 -10 years	More than 10 years	Total
Master	Frequency	0	0	1	1
	Percentage	0%	0%	11%	11%
Product owner	Frequency	0	1	1	2
	Percentage	0%	11%	11%	22%
Team member	Frequency	1	5	0	6
	Percentage	11%	56%	0%	67%
Total	Frequency	1	6	2	9
	Percentage	11%	67%	22%	100%

Table 3: Supplier Agreement Management (SAM)

Practice area	Practice	Mean value	DS	OV	OS
Supplier Agreement Management (SAM)	As stated by the supplier agreement, monitor the supplier and revise the agreement	2.44	S	2.17	S
	Implement and fulfill the tasks and activities outlined in the supplier agreement are met	2.44	S		
	Before accepting the obtained supplier deliverable, confirm that the terms of the supplier agreement	1.89	P		
	Manage and handle supplier invoices in accordance with the terms of the supplier agreements	1.89	P		

Table 4: Configuration Management (CM)

Practice area	Practice	Mean value	DS	OV	OS
Configuration Management (CM)	Determine the items that should be under configuration management.	2.00	S	2.02	P
	Create and maintain an up-to-date configuration and change management system	1.78	S		
	develop baselines for internal usage or customer delivery	2.22	P		
	Control and manage the modifications made to any configuration management item	2.00	P		
	Create, maintain, and utilize records that belong to the items of configuration management	2.00	P		
	Perform a configaraion audits	2.11	P		

Table 5: Requirements Development and Management (RDM)

Practice area	Practice	Mean value	DS	OV	OS
Requirements Development and Management (RDM)	Identify the demands, objectives, constraints, links and interfaces of the stakeholders	2.44	S	2.41	S
	Create prioritized customer requirements using the demands, objectives, constraints, links and interfaces of stakeholders	2.56	S		
	Discuss and understand the meaning of the requirements with the owners of the requirements	2.44	S		
	Assure everyone involved in the project that they can successfully carry out the requirements	2.22	P		
	Trace the requirements with activities or work products bidirectionally	2.11	P		
	Ensure that the plans, actions, and work products conform to the requirements	2.67	S		

DM enables the establishment and maintenance of shared knowledge related to the problems and expectations for a given solution (Jedrzejowska, 2022). Results in Table 5 demonstrate that the RDM is applicable by JAC.

PQA confirms the process is followed and that high-quality solutions are generated (Jedrzejowska, 2022). Table 6 indicates that the PQA is partially applicable by JAC.

G practice area gives direction and guidance to senior management in making sure that work is done in a way that is essential and relevant to the company (Jedrzejowska, 2022). Table 7 provides convincing proof that JAC employs the G practices.

E includes estimating the amount of time, effort, and budget needed to develop and deploy the solution (Jedrzejowska, 2022). Based on the results of Table 8 it is obvious that the E is applicable by JAC.

P is concerned with creating a work plan, timeline, and budget using the estimations; identifying the resources required to carry out the plan of action on time and within budget; and Getting stakeholders' commitment to the work plan (Jedrzejowska, 2022). It is demonstrated in Table 9 that the JAC developers are actively employing the P practices.

MC provides insight into the status of the project so that necessary corrective measures may be implemented when performance dramatically deviates from the plan, schedule, and budget (Jedrzejowska, 2022). It is noticeable from Table 10 that the developers in JAC are partially applying the MC practices.

MPM utilizes measurement analysis to manage performance and accomplish company objectives (Jedrzejowska, 2022). Regarding the MPM practice area, the results of Table 12 show that the JAC is applying the required practices of this PA.

Table 6: Process Quality Assurance (PQA)

Practice area	Practice	Mean value	DS	OV	OS
Process Quality Assurance (PQA)	A quality assurance strategy and plan are created, kept up-to-date and followed based on historical quality data	1.78	P	1.83	P
	Throughout the project, evaluate specific accomplished tasks and work products against the documented process and any appropriate standards	2.00	P		
	Relate quality and non-compliance issues and make sure they are resolved	1.56	N		
	Record and use the QA results	2.00	P		

Table 7: Governance (G)

Practice area	Practice	Mean value	DS	OV	OS
Governance (G)	Organizational directions for process implementation and improvements are defined, updated, and communicated by senior management in accordance with the organization's needs and objectives	2. 6	S	2.47	S
	Senior management makes sure that resources and training are available for creating, implementing, improving and evaluating processes that are required to be followed	2.44	S		
	Senior management determines what information is needed and uses the data gathered to oversee and governance the adoption and improvement of effective processes	2.67	S		
	Senior management holds individuals responsible for following organizational instructions and accomplishing objectives related to process adoption and improvement	2.22	P		

Table 8: Estimating (E)

Practice area	Practice	Mean value	DS	OV	OS
Estimating (E)	Estimated scope should be created, maintained and used	2.56	S	2.44	S
	Create and maintain the size estimations of the solution	2.44	S		
	Create and keep track of effort, time, and cost estimates together with their justification for the solution based on size estimations	2.33	P		

Table 9: Planning (P)

Practice area	Practice	Mean value	DS	OV	OS
Planning (P)	Create and maintain an updated plan for completing the work	2.56	S	2. 39	S
	Make a knowledge and abilities plan that required to do the work	2.44	S		
	Create a budget and timeline based on the estimations that were made and keep them updated	2.78	S		
	Make an appropriate Plan for stakeholder involvement	2.56	S		
	Make a Plan for the transition to operations and support	2.11	P		
	Plans are made assured to be feasible by harmonizing estimated and existing resources	2.44	S		
	Create an updated project plan, that makes sure all of its components are consistent	2.11	P		
	Evaluate plans and get commitments from key stakeholders	2.11	P		

Table 10: Monitor and Control (MC)

Practice area	Practice	Mean value	DS	OV	OS
Monitor and Control (MC)	Keep track of actual outcomes in comparison to the projected size, effort, time, resources, skills and budget	2.11	P	2.28	P
	Track the commitments and participation of the designated stakeholders	2.44	S		
	Monitor the transition to operations and support	2.11	P		
	Take corrective action when actual outcomes considerably diverge from the estimated results	2.44	S		

Table 11: Implementation Infrastructure (II)

Practice area	Practice	Mean value	DS	OV	OS
Implementation Infrastructure (II)	Allocate enough time, money, and training to designing and executing processes	2.56	S	2.5	S
	Create an updated process and check to see if they are being carried out.	2.44	S		

Table 12: Managing Performance and Measurement

Practice area	Practice	Mean value	DS	OV	OS
Managing Performance and Measurement (MPM)	Use the business requirements and objectives to derive, document, and maintain the measurement and performance goals	2.44	S	2.38	S
	Create and update operational definitions for your organization's measurements	2.44	S		
	Get the appropriate measurement data in accordance with the operational definitions	2.56	S		
	Perform an operational definitions-based analysis of the performance and measurement data	2.22	P		
	Make a storage file that includes data, specifications and analysis results that related to the measurements according to the operational definitions	2.22	P		
	Take steps and actions to address problems with achieving measurement and performance goals that have been identified	2.38	S		

II provides a framework that guarantees an organization's processes are consistently used and enhanced (Jedrzejowska, 2022). The results attained from Table 11 make it clear that JAC is applying the II practices.

Based on the findings from Table 3 through 12, it is determined that JAC applies eight PAs: RDM, G, E, P, II, and MPM which is compatible with the findings of the research carried out by Farid *et al.* (2016); Husni *et al.* (2018). However, JAC only applies partially to four PAs. These PAs are SAM, CM, PQA, and MC. In order to improve SAM applicability JAC needs to handle supplier invoices based on the terms of the agreement. According to CM and PQA, JAC developers need to improve the use of all practices related to these practice areas. Lastly, regarding to MC, JAC developers should improve

monitoring of the outcomes based on size, time, and other constraints. In addition, they should support operation transition monitoring.

Conclusion

This study examines the level of applying the CMMI V2.0 practice areas ML 2 based on expert review. Ten PAs are addressed in this study. The degree of supporting each PA is calculated by matching the mean value of each PA and the relevant interval value that was retrieved from Table 1. The results show six out of ten PAs supported to be applicable by JAC. These PAs are RDM, G, E, P, II, and MPM. However, four PAs are partially supported to be applicable by JAC. These PAs are SAM, CM, PQA, and MC. Therefore, JAC needs to put forth additional effort to carry out the necessary practices that are related to these PAs. Consequently, JAC can use the findings of this study to improve their development process and incorporate it with the appropriate practices to get a high maturity level that leads them to achieve their objectives.

Acknowledgment

I appreciate the insightful comments and recommendations provided by the editor and reviewers to improve and update the manuscript.

Funding Information

The authors have not received any financial support or funding to report.

Ethics

This article is original and contains unpublished material. The authors confirm that they have read and approved this document and that no ethical issues are involved.

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