Course code: COMP8173

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1. Answer: For critical software development information needs which already known by Thompson, they are:

- 1. The project manager lacks of information about to assess the feasibility of the current schedule.

- 2. The project manager lacks of information to determine why performance against the schedule was lagging.

- 3. The project manager lacks of information to estimate the overall product qualities of the development products do not meet the quality needs from project DoD's oversight committee.

For the information need which identified by IPT, they are:

- 4. The project has the risk; the existing databases which converted to the shared relational database would fulfil the needs of used by future applications.

- 5. The project has the risk; organizational battles would impact on the process of data standardization needed.

2. Answer: Let us use the information needs number from question 1 answer,

	information needs	information categories	measureable concepts	prospective indicators
Project	1	Schedule and Progress	Work unit progress	1.Porblem reports opened 2.Probelm reports closed 3.Reviews completed 4.Test cases attempted 5.Test cases passed 6.Test cases passed
	2	Process Performance	Process efficiency	Productivity
	3	Product Quality	Functional correctness	Technical Performance Level
	4	Technology Effectiveness	Technology suitability	Requirements coverage
	5	Process Performance	Portability	Standards Compliance

3. Answer: We can drive from this figure

A. Plan effort starts close to zero at project begin, while for the actual effort allocation, it start at almost 15.

B. The number of effort allocation increases faster than plan increase.

C. The majority of duration, the number of effort allocation is stability.

For A, the project may start at a high level of workload, which leads to the high level of actual effort allocation; this situation means that the actual effort allocation did not follow the plan, and there are more staffs than plan needs in this project team. More staff that need means higher cost and lower efficiency.

For B, this kind of faster increase may cause by the increase of the number of staff in the team, this situation shows the project manager allocate the effort not follow the plan, just follow the number of staff in the team. This kind of project management would impact on the process of project and delay the schedule.

For C, the stability of workload leads to stability effort allocation, while from the Figure B-5, we can know that the plan level of effort allocation is not as stability as actual, that means the manager does not follow the plan to allocate the staff, he just allocate the work to suit to the number of members in his team. That may cause by the stability of number of staff in the project team. This situation shows the project manager could not manger the number of the staff as plan and it would impacts on the processes in the project and quality of the product.

4. Answer: For avoid issue which would impact on process of project, project manager should use practical software measurement to address this problem. The project manager should did the plan measurement well **by identify and prioritize information needs**, **select and specify measures** and **integrate into the project processes**. For the issue that lack of staff with experience with SQL, if the project manager could identify this information needs – staff with experience with SQL, and select a measure – **experience level** to indicate the risk of lack of experience staff, after have the plan of experience level, project manager could do **feasibility analysis** with the experience level plan. After all these steps, this issue would be avoiding in the first place.

5. Answer: For Cooper's strategy for the Personnel Information CI, She focus on problem of critical CI was lagging, while for the Figure B-8, she cannot identifies the source of problem. She analyse the information needs – lack of information to identify the source of problem, and select new measurements to help her to identify it. By dividing the Personnel Information CI to Screens and reports and Ada code, she constructed the diagrams about them and identify the source of problem came from Ada code. By her approach, the problem of lack of information to identify the source has been alleviating.

6. Answer: There are several indicators which are presented in the case study: 1. The MAPS development schedule, 2. Effort allocation, 3. Implementation progress, 4. Problem status

report, 5. Problem report discovered, 6. Test progress, 7. Problem report classification, 8. Problem report density, 9. Rework effort, 10, Installation progress. 11. Software size estimate. We can map them to information categories, we get following:

- The **MAPS development schedule**, **problem status report**, **problem report discovered**, **problem report classification**, **test progress**, **implementation progress,** and **problem report density** belong to **schedule and progress**.

-The **effort allocation** belongs to **resource and cost**.

-The **installation progress** and **rework effort** belongs to **process performance**.

-The **Software size estimate** belongs to **product size and stability**.

From the PSM analysis model, we can know that the **technology effectiveness**, **process performance** and **product size and stability** are leading information in PSM analysis model, **resource and cost**, **schedule and progress**, **product quality** and **customer satisfaction** are lagging information in the PSM analysis model. In the other words, **Software size estimate, rework effort** and **installation progress** are provided with leading information, the others are provide with lagging information.

7. Answer: From PSM Analysis Model, we can know that these three '**technology effectiveness**', '**process performance**' and '**product size and stability**' information categories are leading information in the PSM Analysis Model, in the other word, these three information categories can leading to the other four information categories - 'resources and cost', 'schedule and progress', 'product quality' and 'customer satisfaction'. If project manager wants to use measure to indicate his project, and take action to address the problem in the project, he would pay more attention to the leading information in the PSM Analysis Model, because this information would identify the problem earlier than lagging information. And from the relationship between information categories, we can know that 'resources and cost' would impact on schedule and progress. In summary, I think the measures: '**effort allocation**', '**Software size estimate**' and '**installation progress**' are more important for the maintaining control of a project similar in nature to the MAPS project, because installation progress belong to process performance, effort allocation belongs to resource and cost, and Software size estimate belongs to product size and stability, they are more important than other measurement because of their information categories, they would impact on other measurement. For instance, the '**effort allocation**' would provide the information about how the effort allocation in the project, this information would impact on the project manager to make schedule plan and notice the problem like progress is lagging.

8. Answer: For the Figure B-6, it offers the information about effort allocation. The following is the measurement information specification.

Information Need Description	
Information Need	Are the level of staffing profile meet the need of project

Information Category	Resources and Cost
Measurable Concept	
Measurable Concept	Personnel Effort
Entities and Attributes	
Relevant Entities	Effort allocation to the staff
Attributes	The number of effort has been allocated
Base Measure Specification	
Base Measures	1.The number of effort has been plan allocated 2.The number of effort has been actual allocated
Measurement Methods	Add every staff and number of months they worked in the team and add every staff-months number
Type of Method	Objective
Scale	Quantity
Type of Scale	Interval
Unit of Measurement	Staff-month
Derived Measure Specification	
Derived Measure	The gap number of effort allocation between plan number and actual number in the project
Measurement Function	Get the absolute of number of gap of plan number and actual number
Indicator Specification	
Indicator Description and Sample	Collect data by calculate project effort
Analysis Model	The high level of gap of plan effort allocation and actual effort allocation must be evaluated with a root-cause analysis
Decision Criteria	The gap of plan effort allocation and actual effort allocation is above 15% of plan number, it must be investigated for root cause and to determine if a new effort allocation plan is needed
Indicator Interpretation	When the gap of plan effort allocation and actual effort allocation is above 15% of plan number, the PM would be mark this phase of effort allocation

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	and analysis the source of this problem and how to deal with it in the report.

Data Collection Procedure	
Frequency of Data Collection	Every two months
Responsible individual	Project manager
Phase or Activity in which Collected	During all over the project
Tools Used in Data Collection	N/A
Verification and Validation	N/A
Repository for Collected Data	PSM Insight database
Data Analysis Procedure	
Frequency of Data Reporting	Every two months
Responsible Individual	Project manager
Phase or Activity in which Analysed	During all over the project
Source of Data for Analysis	PSM Insight database
Tools Used in Analysis	PSM Insight
Review, Report or User	2-monthly report
Additional Information	
Additional Analysis Guidance	Calculate the effort allocation should consider of the holiday of the schedule
Implementation Considerations	Staff reports their effort every week is easier way to calculate the effort by project manager to check the details of staff effort allocation every two months.

For the Figure B-14, it offers the information about test progress. The following is the measurement information specification.

Information Need Description	
Information Need	Is the increment 1 ready to begin operational test?
Information Category	Schedule and progress
Measurable Concept	
Measurable Concept	Work Unit Progress
Entities and Attributes	
Relevant Entities	Cases which are been test
Attributes	The number of test cases
Base Measure Specification	

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Base Measures	1. The number of test cases which are planned 2. The number of test cases which are attempted 3. The number of test cases which are passed
Measurement Methods	Count the number of test cases which are planned, attempted and passed.
Type of Method	Objective
Scale	Quantity
Type of Scale	Interval
Unit of Measurement	Number of test cases
Derived Measure Specification	
Derived Measure	1. The ratio between passed number and attempted number 2. The ratio between passed number and planned number
Measurement Function	1. Get the absolute of number of gap of attempted number and passed number, and use gap to divide to attempted number 2. Get the absolute of number of gap of planned number and passed number, and use gap to divide to planned
Indicator Specification	
Indicator Description and Sample	Collect data by calculate number of test cases
Analysis Model	1.The low level of ratio of passed test cases and attempted one must be evaluated with a root-cause analysis 2. The low level of ratio of passed test cases and planned one must be evaluated with a root-cause analysis
Decision Criteria	The ratio is lower than 85%, it must be investigated for root cause
Indicator Interpretation	The ratio is lower than 85%, the Project manager should mark this phase and analysis the source of this problem and how to deal with it in the report.
Data Collection Procedure	
Frequency of Data Collection	Every two weeks
Responsible individual	Quality manager
Phase or Activity in which Collected	Evaluating readiness for test

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Tools Used in Data Collection	N/A
Verification and Validation	N/A
Repository for Collected Data	PSM Insight database
Data Analysis Procedure	
Frequency of Data Reporting	Every two weeks
Responsible Individual	Quality manager
Phase or Activity in which Analysed	Evaluating readiness for test
Source of Data for Analysis	PSM Insight database
Tools Used in Analysis	PSM Insight
Review, Report or User	Readiness for test report
Additional Information	
Additional Analysis Guidance	Calculate the number of test cases should consider of the repeat one
Implementation Considerations	Test case writers could submits the report of test case statues to help manager to calculate this measurement

9. Answer: For established an effective measurement program, project manager should **identify and prioritize information needs**, **select and specify measures** and **integrate into the project processes**. After these three steps, project manager establish an effective measurement program. For the similar to the MAPS Project, project manager should start at **identify and prioritize information needs**, we could identify the problem (of course it is one of the information needs) the overall product qualities of the development products do not meet the quality needs from project DoD's oversight committee. Then map this information need to ICM table to get the measureable concepts and prospective indicators of this information need. Next to the step of **select and specify measures**, project management would characterize project context, define measurable concepts, select the applicable measure and specify measurement constructs, in the similar project to MPAS Project, we could select the number of defect as a measurement to indicator the quality of the product, because it is applicable measure and could be constructed. At the end of establish measurement program, the last step is '**integrate into the project process**'. The project manager would identify measurement opportunities, develop measurement procedures and document measurement plan. In the MAPS Project, the number of defect would be documented the plan like question 8 answer showed. After every information needs in the MAPS Project has went through these three steps, we could establish an effective measurement program of this project.

10. Answer: From the Maturity Profile Report in September 2013, we can derive the types and sizes of organisation in the report; there are six types of process maturity profile, they are: **not given**, **initial**, **managed**, **defined**, **quantitatively managed** and **optimizing**, there are

three types of organization, they are **commercial/In-house (77.3%)**, **contractor for military/government (18.7%)** and **military/government agency (4.1%)**, and there are ten types of size, they are: **25 or fewer (18.5%), 26 to 50 (24.59%), 51 to 75 (12.38%), 76 to 100 (8.46%), 101 to 200 (15.87%), 201 to 300 (6.52%), 301 to 500 (5.81%), 501 to 1000 (4.26%), 1001 to 2000 (1.96%), 2000+ (1.66%)**. The following is the percentage breakdowns of the main organisation types which are embarking on CMMI based improvement programs and their maturity types.

Maturity type	Commercial/In-house	Contractor for military/Government	Military/Government agency
Not Given	2.2417%	0.4114%	0.6683%
Initial	0.6957%	0.1122%	0.2419%
Managed	17.2379%	5.5165%	1.8819%
Defined	50.5542%	11.3135%	0.9717%
Quantitatively	1.4687%	0.1496%	0.1558%
Optimizing	5.1018%	1.1781%	0.1804%

From this table, we can know that the highest percentage of organization type is commercial/In-house (50.5542%), and its maturity type is defined.

The following is the percentage breakdowns of the main organisation sizes which are embarking on CMMI based improvement programs and their maturity types.

Maturity type	25 or fewer	26 to 50	51 to 75	76 to 100	101 to 200
Not Given	1.2332%	0.2782%	0.2367%	0.2367%	0.2481%
Initial	0.3083%	0.1391%	0.0789%	0.0789%	0.0827%
Managed	13.8735%	3.1993%	1.8936%	1.7358%	1.4886%
Defined	15.4150%	10.0152%	5.3652%	5.1285%	5.6236%
Quantitatively	0.0000%	0.1391%	0.1578%	0.1578%	0.1654%
Optimizing	0.3083%	0.1391%	0.2367%	0.5523%	0.5789%
Maturity type	201 to 300	301 to 500	501 to 1000	1001 to 2000	2000+
Not Given	0.3156%	0.3385%	0.3385%	0.3312%	0.0564%
Initial	0.0789%	0.0677%	0.0677%	0.0000%	0.0564%
Managed	1.5780%	0.2708%	0.7447%	0.2070%	0.3384%
Defined	4.8918%	4.4005%	3.9943%	2.3598%	2.9328%
Quantitatively	0.3156%	0.1354%	0.1354%	0.0000%	0.0564%
Optimizing	0.8679%	0.9478%	1.5571%	1.2420%	2.3688%

From this table we could know that the highest percentage of organization size is 25 or fewer (15.415%), and its maturity type is defined.

11. Answer: There are six benefits that have been reported by organisations in implementing CMMI based improvement programs, they are **Decreased Costs**, **Improved On-Time Delivery**, **Improved Productivity**, **Improved Quality**, **Improved Customer Satisfaction** and **Impressive Return on Investment.** By implementing CMMI based improvement

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programs, many companies get benefits from it. For **the decreased cost**, Siemens Information Systems Ltd. reduced its cost of quality from over 45 % to under 30% over a three-year period, General Dynamics Advanced Information Systems reduced maintenance staff costs by 64% while doubling the size of the organization. For **improved On-time delivery**, General Motors improved the precent of milestones met from 50% to 85%, Raytheon North Texas Software Engineering improved schedule performance by 8% with a 50% decrease in variation. For **improved productivity**, Raytheon North Texas Software Engineering improved schedule performance by 8% with a 50% decrease in variation. For **improved quality**, Siemens Information Systems Ltd. reduced defect density an average of 71% in three technical areas. For improved customer satisfaction, Lockheed Martin Management and Data Systems increased their award fees by 55%. For impressive return on investment, Lockheed Martin Management and Data Systems increased their award fees by 55%, Siemens Information Systems Ltd. experienced 2 to 1 ROI over 3 years.

12. **Answer:** There are **two** generally accepted representations, they are **continuous** and **staged**. In the **continuous representation**, the 22 process areas are grouped by their relationship, the process area which focus on the similar part of project would be group together, so for each group, it focuses on several activities in the project. This representation would help organization to improve their individual process on capability level. The four groups are:

Process Management: Organization Process Definition, Organizational Process Focus, Organizational Performance Management, Organizational Process Performance and Organizational Training

Project Management: Integrated Project Management, Project Monitoring and Control, Project Planning, Quantitative Project Management, Requirements Management, Risk Management and Supplier Agreement Management

Engineering: Product Integration, Requirements Development, Technical Solution, Validation and Verification

Support: Causal Analysis and Resolution, Configuration Management, Decision Analysis and Resolution, Measurement and Analysis and Process and Product and Quality Assurance

In the **staged representation**, the 22 process areas grouped in five groups by their relationship to maturity levels groups. Each group focus on the different management level in a organization. This representation helps the organization to improve their maturity level by evaluate these process areas in the groups, these groups are:

Maturity level 5 (**Optimising**): 1. Organisation Performance Management 2.Causal Analysis and Resolution. It focuses on the continuous process improvement.

Maturity level 4 (**Quantitatively Managed**): 1.Organisational Process Performance 2. Quantitative Project Management. If focuses on the quantitative management,

Maturity level 3 (**Defined**): 1.Decision Analysis and Resolution, 2.Organizational Process Definition, 3.Integrated Project Management, 4.Organizational Process Focus, 5.Organiatinoa Training, 6.Product Integration, 7.Requirements Development, 8.Risk Management, 9.Technical Solution, 10.Validation, 11.Verification. It focuses on the process standardisation.

Maturity level 2 (**Managed**): 1.Configuration Management, 2.Requirements Management, 3.Project Planning, 4.Project Monitoring and Control, 5.Measurement and Analysis, 6.Supplier Agreement Management, 7.Process and Product Quality Assurance. It focuses on the basic project management.
Maturity level 1 (Initial) has no process area.

13. **Answer:** These two terms have the same concept, they characterise the **improvement path**, and to reach a capability or maturity level, the organisation must satisfy all the goals of the process areas in question up to and including the level in question. They both provide a way to improve the processes of an organization and measure how well organizations can and do improve their process. Moreover, these two terms both defined how the process **performance** in the project.
However, the associated approach to process improvement is different, the two terms represent 'continuous' and 'staged' respectively. In other words, capability level relative to the **individual process area** capability and maturity level focus on the **overall organisation** maturity level. Capability level can be achieved by using the continuous representation, and maturity level can be achieved by using the staged representation. The capability levels has four levels, they are 'level 0 Incomplete', 'level 1 Performed', 'level 2 Managed' and 'level 3 Defined'. The maturity levels has five levels, they are 'level 1 Initial', 'level 2 Managed', 'level 3 Defined', 'level 4 Quantitatively Managed' and 'level 5 Optimizing'.
The **required components** are essential to achieving process improvement; they are the specific and generic goals in every process area, and they used in appraisals as the basis for deciding whether a process are has been satisfied. The **expected components** describe the activities that are important in achieving a required CMMI component; they are the specific and generic practices in each process area. The informative components help model users understand CMMI required and expected components, they can be example boxes, detailed explanations or other helpful information, it provides information necessary to achieve the correct understanding of goals and practices.

14. **Answer:** The SP3.2 in the Project Planning process area is 'reconcile work and resource level'. It is important in adjust the project plan to reconcile available and estimated resources because it can make the plan **realistic**. The project should be feasible, so obtain commitment from relevant stakeholders and reconcile differences between estimates and available resources are important. When facing some fixed factors in the project background, it is important for project managers to adjust the project plan and make it feasible. For instance, reconcile the scope, time and cost factor in the project, and make them balance in the plan. After this action, the project plan can be estimate a really and reliable project. Without this action, the project plan is unrealistic and useless.

15. **Answer:** The **specific practice 1.4** (maintain bidirectional traceability of requirements) in **Requirements Management** identifies the need to maintain bi-directional traceability between requirements and project work products. It helps the project to covers relationships to other entities, and it particularly assess the impact of requirements changes on project

activities and work products. It also can helps to determine whether all source requirements have been completely addressed and whether all lower level requirements can be traced to a valid source.

16. Answer: The **specific practice 3.1** (develop risk mitigation plans: given risk includes techniques and methods used to avoid, reduce and control the probability of risk concurrence; the extent of damage incurred should the risk occur; or both), **specific practice 3.2** (implement risk mitigation plans: monitor risks and the status and results of risk handing actions) in **Risk Management** describe what should be done when mitigating risks. There are **five** ways to handle the risk; they are 1. 'accepted risk' (acknowledging and no action), 2. 'reduce probability of the risk and keep consequence of the risk', 3. 'keep probability of the risk and reduce consequence of the risk', 4. 'reduce both' , 5. 'transfer / share the risk'. Because in the action to mitigate risk is about reducing probability and consequence, so the risks which are related to high level of probability and serious consequence would be typically mitigated. At the same time, for the objective risks is easier to reduce than subjective factors, because it is easy to reduce the probability or reduce the consequence, no matter change the scope or change the requirement, they are easy to monitor and control. For the subjective factors like staff level, they are hard to identify, monitor or control.

17. Answer: The SP3.1 in the Requirements Development process area is 'Establish Operational Concepts and Scenarios'. It describes establish and maintain operational concepts and associated scenarios. This practice is signification because it is testing the requirement which would impact on the quality of the product. The requirement would collect and changed in the lifecycle in the project, while they should be tested by the project team. This practice is **validating** the feasibility of the requirement. However, project manager have **no time to test everything** when the requirement change across the lifecycle. Then we use the operational concepts and associated scenarios which have been established in this practice to make explicit some of the functional or quality attribute needs of the stakeholders. Then we could use these items to improve the processes of projects and product.

18. Answer: For the verification, it focuses on the ensuring the selected work products meet their requirements, and validation focuses on demonstrating that a product or product component fulfils its intended use when placed in its intended environment. In other words, verification consider of the product is been built in the way which based on the input information (requirement), and validation consider of the product whether meet the intended used environment. In short, validation test the product is useful, and verification tests the product meet the requirement. The **verification** involves the following activities: evaluation work products against specification, conducting product quality evaluations compared with quality assurance evaluations. The **validation** involves the following activities: evaluating work products against operational concepts and use scenarios, determining the 'fitness for use' of work products.

19. Answer: From the Specific Goal 2 of the Verification process area, peer reviewing is significance way on identify and remove defects on the selected work products. For the

identifying and removing defects, it should be performed in a right and effective way. The specific practice 1 'prepare for peer reviews' is identifying the staff to be invited to participate in the peer review of work product and preparing and updating materials to be used during peer review. This practice would help to make appropriate staff to review this product and right criteria have been reviewed. This action would make the right people to identify the defects in product based on the right materials; it can make the defects identified in a right way. The specific practice 2 'conduct peer reviews' is conduct peer reviews products and identify issues resulting from these review, this action would identify the defects and issues in the work product and record the results of the peer review. This practice would help project manager getting the peer review results, issue and data, and get the defects in the product. The specific practice 3 'analyze peer review data' is analyse how long it would take to review, who will do this job and this review is effective or not. This action would make the peer review performs in an effective way, and make project manager to know the cost of defects removing. This practice could make the defects removed in an effective and appropriate way. After these three practices, we would verify selected work products well in the next steps.

20. Answer:

Practice	Characterisation (FI, LI, PI, NI or NY	Strength(s)/Weakness(es)	Objective Evidence - Artifacts, - Affirmation
REQM SP 1.4	PI	(S) The Telelogic DOORS is useing as a requirements tracking system. (S) The Telelogic DOORS database establishes traceability automatically. (W) The first one year of this project not store all the trace of requirements in Excel by software engineer. (W) The Telelogic DOORS has not yet make requirement trace flow down to the lower level requirements.	(Artifact) Telelogic DOORS (Affirmation) Interview session with software engineer (Affirmation) Interview session with hardware engineer (Affirmation) system demonstration (Artifact) Excel spreadsheets and Word documents which store requirement in the first year of project