DEVELOPMENT-PROCESS-FLOW TEMPLATES TO ADVANCE A FUNCTIONAL PRESENTATION OF THE DAMA CURRICULUM FRAMEWORK TO ENSURE INFORMATION QUALITY BY ACHIEVING CMMI LEVEL 3 IN ENTERPRISE PROJECTS

(PRACTICE-ORIENTED)

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ABSTRACT: The Data Management Association (DAMA) published body of knowledge framework defines the responsibility of IT professionals across the development life-cycle with respect to the domain of information engineering. Yet, it is not information that is power, it is applied information. The Capability Maturity Model (CMMI) of the Software Engineering Institute (SEI) promotes not only managing a project but utilization of a well defined methodology that can be improved by measurement and repair processes. The DAMA Body of Knowledge (BOK) suggests richly a set of skills. We demonstrate a sequence of templates controlled through a prescribed development-process-flow that can enable a team to achieve CMMI level 3 processes for data management,

providing a high level of information quality. Furthermore, we propose an international repository of collected reviewed exceptional templates for information engineering that will significantly improve the IT industry.

KEYWORDS: Information Quality, Information as a Product, Development Templates, CMMI

INTRODUCTION

The data management profession is represented well through the Data Management Association (DAMA) Curriculum Framework [7]. It is a group of esteemed individuals who typically have in excess of 20 years of experience, most of whom have had ten years of prior business and information systems experience before being hired into their profession. Data management is therefore regarded as an "elusive profession" [9] since the entry level requires so much prior experience.

The DAMA Curriculum Framework contains a body of knowledge describing the skills of the profession. These skills are abstracted in Figure 1.

We observe that the skills represented within the outline of the Framework and the DMBOK Framework [8] can be arranged in life-cycle order. That is, each element of the body of knowledge has its place somewhere within the developmental life-cycle of information technology (IT) projects: Identifying, defining, implementing and utilizing the highest possible quality enterprise information achievable.

The entire DAMA Data Management Body of Knowledge occupies a row [6,11] of the table in Figure 2. The DMBOK describes the skills utilized by a data management professional. In a similar manner, the work of systems engineers occupies one row, and the work addressed by software engineers occupies a third row, and so on.

"Information Engineering": Data Life Cycle Management

- Data Information Governance and Stewardship
- Data Requirements Analysis and Documentation
- Data Modeling, Access and Security
  - Planning for Data & Metadata
  - Data Quality
  - Data Models and Modeling
  - Relational Data Model
  - Data Warehousing
  - Data Security
- Physical Database Access and Management
  - Data Storage Management
  - Data Access and Database Programming
  - Database failures, backup and recovery procedures
- Standards Creation, enforcement, maintenance

Figure 1. Abstraction of the DAMA Framework Body of Knowledge

The implication of the figure is that multiple professions make up the IT project scene. We suspect that for each row of this figure it is possible to identify corresponding professional representatives who occupy one and only one horizontal row of the table. We also believe that information systems professionals, particularly in smaller organizations, might take responsibilities for all of the activities of the first three rows.

CMMI Technical Policy	1.4.1 System Initiation	1.4.2 Systems Analysis and Design			1.4.3 System Component Design		1.4.4 System Implementation		1.4.5 System Integration, Test and Evaluation		1.4.6 System Operation and Support		System Evaluation	System Maintenance
Systems Engineering **INCOSE**	System Feasibility / System Planning	System Reqmnts Analysis	System Design / Interface Identification	Verification, Validation and Certification Test Plan	Verification with customer of reqmnts	Verification of detailed design	Module validation with customer review	Application Validation with customer review and acceptance	System Reqmnts Validation	Final System Evaluation	System Acceptance and operation validation	Initial Operation; Post Implementation Cleanup; Certification	System Performance Review	Evaluation of Customer Satisfaction and CSF Attainment
Information Engineering **DAMA**	Data / Information Governance and Stewardshp	Information Reqmnts	Data Base and Warehouse Architecture	Data Reqmnts Analysis / Metadata Reqmnts Analysis	Database Table & Stored Procedure Identification	Detailed Design & Database Scripts; DQ Planning	Stored Procedure & Trigger Construction & Testing	Conversion Planning and Construction	Conversion Testing	Data Evaluation	Database Deployment; Data Conversion Configure	Database Admin; Backup and Recovery Deployment	Capacity Performance & Quality Review	Database Admin: Access Mgt Backup Recovery
Software Engineering **SEI**		Software Systems Analysis	Software Systems Design	Software Rqmnts Analysis	Software Module (Page and Reports) Design	Detailed Software Layout (Screens & Reports)	Software Construction & Module Testing	Software Integration Testing	System Integration	Software Evaluation and Certification	Software Installation and Testing	Software Maintenance	End User Software performance analysis	Software Maintenance and Updates
Business Proc **IIBA** **ess**	Customer Reqmnts Analysis / Business Plan	Business Goals and Objectives	Business Policy	Stakeholder Analysis	Work Flow Procedure Writing	Job Design	Procedure Manual Construction	Business Conversion Planning	Business Process System Support Evaluation	Final Acceptance Review	Job Training	Business Cutover and Initial Operation	Customer Satisfaction and Business Objectives Review	Customer Satisfaction And Business Process Efficiency and Profitability

Figure 2. Life-cycle Relationships between Systems Engineering, Information Engineering, Software Engineering, and The International Institute of Business Analysis.

In the professional world, a focus on quality improvement is becoming increasingly important. Failure statistics reported by the Standish Group have been well known, and perhaps even tolerated. Unfortunately until recently there has been little improvement. However, with the development of the Capability Maturity Model Integrated (CMMI), there seems to be a very well defined mechanism for improvement, primarily focused on software development,. However, with pressure brought to bear on poor quality of information because of costly corporate failures, there is a new and sustained focus on Information Quality (IQ). This is certainly occurring because of the increasing visibility of the work of Richard Wang and colleagues. Likewise, DAMA has fully embraced this mission. Indeed the concept of CMMI as applied to data management was presented by Peter Aiken at a recent DAMA conference[1] .

WHY FOCUS ON CMMI?

CMMI [2] is a quality model developed by the Software Engineering Institute [1] of Carnegie Mellon University. The Department of Defense invested in SEI in order to achieve higher software quality. In a second effort, the concept of the maturity model was extended to include integrated life-cycle components between systems engineers and software engineers. The essence of the model is expressed in Figure 3. The CMMI is cast as a five level structure to be successively achieved by a desirous organization. An organization must commit to following the CMMI guidelines published by the SEI [2,3]. For example, an organization compliant with CMMI level 3 would be utilizing project management, and characteristic of the level would have a well developed written methodologies.

With the CMMI guidelines, organizations are evaluated by their ability to be in conformance with the demands of each level. The metaphor of maturity implies that a previous level must be integrated into an organization's practices before the next level can be attained. There is a formal process for any organization striving to be qualified at any given level that is provided by the SEI. These guidelines can

[1] Aiken, Peter (May 2005). Assessing Data Management Maturity (DM3). Presented at the Wilshire Meta-Data Conference / DAMA International Symposium , Orlando.

be used as a self-assessment tool by an organization wanting to improve its processes, or as a certifying framework for external validation of quality-focused practices. Periodic independent 3rd party audits confirm continued compliance at the attained level.

Level	Title	Explanation
1	Initial	Unmanaged, Undefined, Chaotic
2	Managed	Requirements managed, projects are planned, monitored and controlled
3	Defined	Processes are described and understood for each stage and activity of the life cycle
4	Quantitatively Managed	Statistical and quantitative techniques are applied for process performance analysis
5	Optimizing	Process are continuously improved based on measurements

Figure 3. CMMI Levels Defined

Level 1 behavior is characteristic of the behavior of many, if not most organizations, and unfortunately the results summarized by the Standish Group are the result of the behavior, that is, failure. To be sure, achieving level 2 is a significant step forward. It is really not much better. In a house building analogy, level 2 would mean that a well managed contractor would be trying to build your house using unknown as well as ad hoc methods that were not repeatable. Certainly, if you knew that's what was going on you would find it totally unacceptable. We agree, the lowest acceptable standard to consistently deliver quality products and services should be level 3.

CONCEPT OF FUNCTIONAL PRESENTATION

The expression of a body of knowledge represents a large step forward. It codifies the knowledge that is expected of professionals. Indeed, it has been the basis for development of certification exams for the Certified Data Management Professional (CDMP)[7] by DAMA International and Institute for Certification of Computing Professionals for the data management profession. While these certifications tell us that individuals measure up, we feel there is a more profound goal, that is, to enumerate a mechanism to elevate the behavior of professionals and their organizations to at least level 3, that is to achieve "good practices".

We propose to develop a sequence of templates that will help current or future professionals to instantiate "good practices" and will provide a mechanism for ensuring that template users will rapidly reach level 3 behavior. These templates will present a mechanism that could be used to achieve a specific result. The template would serve as a starting place for a user who would adapt the template to their specific circumstances. Thus it would serve as guidance.

The intent of the DMBOK is to provide a comprehensive coverage of activities of data management professionals. We propose to tie the templates to the DAMA Body of Knowledge. We argue that it is not enough to know of the existence skills described within the DMBOK. The existence of software engineering reference material since the 80's did little to offset the behavior referenced by the Standish Group. Rather, for each problem solved within the life-cycle, a template can provide precise guidance to

the user as defined in Figure 4. Therefore, the proposed collection of templates would comprehensively parallel the skills outlined in the DMBOK, and of the life cycle skills referenced in row 2 of Figure 2

We refer to this approach as a *functional presentation* as opposed to a static topic listing. Within this functional presentation a template user would find precise guidance and instruction into all aspects of the given skill, or step of a the methodology. The explicit instructional methodological guidance can be used as an instructional tool to ensure that the right approach to build the right thing is accomplished. Since the template contains an example, the process of using the template is what software writers call "cloning", that is modification of the work product until it is in final form. Since the work of the life-cycle is done fully within the template, the template itself becomes the work product. In the final step, the instructional guidance within the template may be deleted.

The Template must accomplish all of the following:	
1	Reference to the Body of Knowledge
2	Define clearly the function performed by the template
3	Provide housekeeping details for project owner, template user, quality control, etc. staff listings, version tracking, and a table of contents.
4	Enumerate the desired starting parameters
5	Provide detailed step by step instruction clearly explaining any constraints. Do not rely on external sources to accomplish the task
6	Provide a complete example of the task to be accomplished wherein the principles of instruction are revealed through explicit work product
7	Provide a mechanism for step-by-step assessment of the work product
8	Provide a mechanism for assessment of the effectiveness of the template that can be used for improvement of the template
9	Use color codes or various fonts to show what portion of instruction can be deleted from final copy, what is boilerplate, and what is expected template-user supplied text

Figure 4. Functional Presentation Template Characteristics

Assessment mechanisms are also provided within the template. The work product assessment section will ensure that the template user pays attention to detail, and fixes aspects of the work product until it matches the desired characteristic. It may also provide a type of rubric for peer review of the work product. Also, we have found that templates with assessment criteria also provide a common framework for team members to provide constructive feedback for one another – thus improving overall quality of the work product.

Importantly, within a template assessment section, questions are asked about the utility of the template. This practice gives the template user the opportunity to feed back critical thinking about how the template may be fixed in the future. It in fact taken in aggregate provides the necessary measurement criteria compliant with CMMI level 4, and can enable level 5 processes in a desirous organization.

INTEGRATION OF TEMPLATES IN THE DEVELOPMENT WORK FLOW

A *development work flow* or *engineering work flow* consists of a sequence or network of templates which solve a specific problem. A life cycle consists of repeated implementations of development work flows to ensure the desired project outcome. An enterprise may have multiple development work flows to accomplish various sub-phases of the life cycle. In the appendix two sample life cycle work flows are presented. Appendix 1 is a partial illustration of the methodology for development of a data modeling technique to build a top down levelized conceptual relational model for a stated problem. The technique is simple graphical representation in which only 1:n relations are shown, with the "1" side always at the top. The drawing also shows left to right precedence which causes many observers of the diagrams to confuse the conceptual model with a system work flow. Appendix 2 is a partial illustration of a solved data architecture for a large power company. In both these examples black and white representations are used to illustrate the sections of the templates. In fact we utilize colored text to rapidly differentiate sections of text. Also, only a single component of the development work flow is shown.

Project management is greatly simplified through the use of development work flows and templates. Each of the templates has a very small scope and solves a specific problem very well. Since the templates are self-documenting, project documentation is flawlessly up-to-date. The project manager's job is simplified into one of template assigning and tracking. Therefore, if the project manager wants to ensure standards of information quality control in the development life-cycle, the project manager need only ensure that adequate research is represented in the template designs to be used, and that resultant work products are compliant with the designed template architecture. The iterative nature at the detail level is recognized and controlled through work product versioning.

BUILDING A TEMPLATE REPOSITORY

DAMA has provided an extensive body of knowledge as a service to the professional and academic community. It is our feeling that templates would make a good way to share our understanding of the implementation and instantiation of elements of the body of knowledge. We recognize that there are many difficulties in proposing such an approach: 1) Much corporate process knowledge is secrete, and represents a competitive advantage for the holder of the knowledge; 2) Presented templates are probably not directly usable by the community, and would represent only guidance; and 3) A set of templates represents a lot of work.

DAMA proposed to provide a framework to which people will be able to submit completed and validated templates, tied to its body of knowledge. DAMA intends to promote, encourage, solicit and reward participation through publication and national exposure. These cataloged templates will be available for use by the academic and corporate community. Submission rules, a rigorous review process, and publication details will be published. BOK Phase 1 is focusing at an overview level, validating the framework and slotting in data management topics. A template repository is planned for development during Phase 2 of the BOK development.

IMPACTS OF UTILIZING TEMPLATES

The authors have utilized various manifestations of these templates both in industry and in academic settings[4,5,10]. The templates provide guidance for good practice, yet they can evolve with continued use due to the built-in self improvement mechanisms. They serve to provide instruction and example of the work process and provide a uniform mechanism for project documentation. Metrics included with the templates do provide a method of quality control to ensure that standards are followed, and that template difficulties are detected and corrected.

The process of development of these templates may be an area where academia can truly make a difference for improving our professions. As academics partner with industry to incorporate best practices into courses, without violating copyrights or disclosure agreements, academics will be training "best in breed" professionals who will be able to make creative contributions to industry when they graduate from our programs! It's a win-win.

In summary, we proposed, and will attempt to demonstrate that the functional presentation of a professional body of knowledge, such as the DMBOK, can be implemented into practice as template-based processes throughout the information systems lifecycle. This provides an effective means for an organization to achieve the defined process characteristics representative of the SEI's CMMI level 3. Consistent, continually improving data documentation and database development practices will lead to more accurate, current and accessible information. The bottom-line impact to an organization is that higher quality information is developed in a timely, consistent manner and development dollars are not squandered in directionless activity.

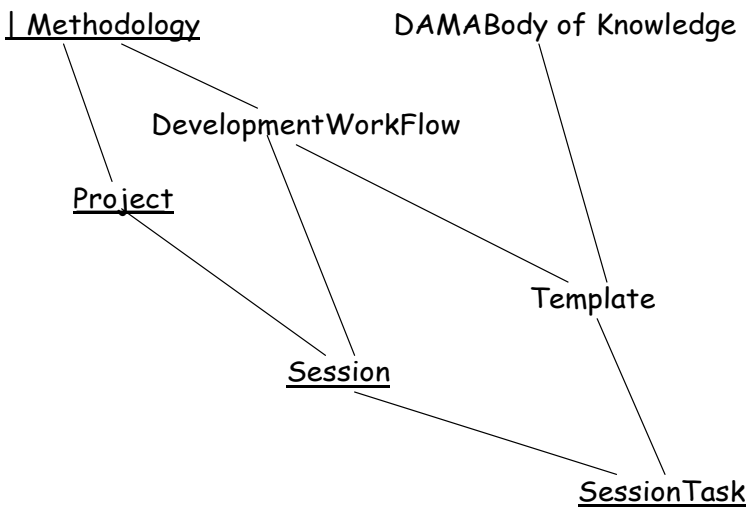
APPENDIX 1. DEVELOPMENT WORK FLOW 18 AND PARTIALLY COMPLETED TEMPLATE 18.109.

This work flow has been implemented in our academic and industrial settings with success both for simulated and real clients.

Development Work Flow 18: Build Small Enterprise Database		
#	**Template Name**	**Template Number**
1	Project Overview	18.101
2	Background	18.102
3	Goals and Benefits	18.103
4	People, Systems, Roles	18.104
5	Scope	18.105
6	Template Schedule	18.106
7	SWOT Analysis	18.107
8	Business Process and Story Development	18.108
9	Top Down Levelized Conceptual Relational Model	18.109
10	List of Entities with Description	18.110
11	Composite Key Identification	18.111
12	Status Table Descriptions	18.112
13	Metadata	18.113
14	Schema Script	18.114

Development Work Flow 18
Template 18.109: TDLCRM
Project: Template Management System (TMS)

Do not alter structural text like this or *This text furnished by end-user*
Delete this instructional text on final version

1. BOK	Data Modeling
2. Function	Build a top down levelized conceptual relational model from a user defined story describing a process
3. Authors	Project Manager Authors Quality Control Status (IP,F)
4. Given	A story describing the operation of the new system without reference to specific people or roles (see template 108, 104)
Instruction (delete in final version)	Examine the story. Highlight nouns that are likely to be entities. Do not highlight persons or roles. Note words that pertain to status of the entities should not be highlighted. The phrases connecting the entities define relationships usually 1:n in nature. In a separate PowerPoint slide place each entity word in a text box (no boarders). Arrange the words in top-down-left-to-right order. If one of the entities came first it would be shown higher and to the left. Connect the words according to the relationships identified by the story. If an entity has a status underline it, if it has versions | mark it like this. Copy the slide from slide sorter view, paste in the template and crop. The symbols have meaning in implementing the database (see template 110-114)
Given Data	***A project is accomplished according to a version of a methodology in sessions which during planning is accomplished by selecting a development-work-flow (DWF) of the methodology. Within the session, tasks consists of identifying, doing and completing a single template of the DWF described by the body of knowledge***
Work Product (WP)	
Work Product Assessment	**Work Product 18.109: TDLCRM—TMS** 3=meets expectation 2= partial 1=poor 0=nothing

Explain responses less than 3

#	Item	Score	Review
1	All entities of the story are captured in the story	*3*	
2	Entities are differentiated from states and attributes	*3*	
3	The drawing is top-down and left to right in the same sense as the story	*3*	
4	Relationship lines appear to "flow" within the drawing	*3*	
5	The "flow" of the TDLCRM is equivalent to the order of the story	*3*	
6	A story recreated from the TDLCRM is equivalent to the original story	*3*	
7	Entities with significant state variables have been identified	*3*	
8	Entities which are versions have been identified	*2*	*It is suspected that the body of knowledge will change so there will have to be versions.*
Average Score		*2.9*	

Template Assessment

Template 18.109: Assessment Document

Assessor:

Date: July 8, 2006

#	Score	Question	Comment
1	*3*	The template carries out the task I was expecting to see	
2	*2*	Template directions are written clearly	*Some directions were absent or not very clear. Flow was not explained clearly*
6	*2*	The template is complete as it stands	*The instructions need to be improved as indicated*

APPENDIX 2. DEVELOPMENT WORK FLOW 12 AND PARTIALLY COMPLETED TEMPLATE 12.101.

This work flow has been submitted with one of the templates completed. This template comes from a real project to manage collection data for a large utility company.

Development Work Flow 12: Development of a Data Architecture[2]		
#	**Template Name**	**Template Number**
1	Purpose and Scope	12.101
2	Framework for Recommendation Drafting and Review	12.102
3	Stakeholders	12.103
4	Minutes of Meetings	12.104
5	Background	12.105
6	Problem Statement	12.106
7	Issues—Handling of data flow design	12.107
8	Issues—Selection of the system record	12.108
9	Issues—Database deployment	12.109
10	Issues—Modeling	12.110
11	Alternative 1	12.111
12	Alternative 2	12.112
13	Application deployment	12.113
14	Recommendation	12.114
15	On-going Deviation to Standard, Policy, Principle or Practice as a Result of This Recommendation	12.115

[2] Used with permission : CapGemini 2006

DEVELOPMENT WORK FLOW 12
TEMPLATE 12.101: PURPOSE AND SCOPE
PROJECT: - Name

Do not alter structural text like this or *This text furnished by end-user*
Delete this instructional text on final version

1. BOK	Data Architecture
2. Function	This template is to be used to document an architecture recommendation that is developed jointly by architects and clients.
3. Authors	Project Manager: Client Representatives: Quality Control: Status (IP,F):
4. Given	***Management directive to initiate this project. This is an initial project document.*** *The CEO has ordered this recommendation to consolidate planning for Enterprise Systems.*
Instruction (delete in final version)	As a draft, it is a discussion document. As a final, it is a joint recommendation to the Manager of Architecture as per the 'Monitor Compliance of Architecture Standards and Guidelines' joint activity of clients and developers. Refer to reference architectures for governance as appropriate and copy in AS-IS architecture diagrams as base reference for changes as appropriate The section documenting meetings is to have RoM (records of Meeting minutes) embedded for reference. This completed template will be incorporated with a Service Request or Project proposal as directed. This document is attached as an appendix to a Service Request or a Project proposal as required. Please complete all sections 12.102-12.115.
Work Product (WP ***PARTIAL EXAMPLE***)	*The purpose of this document is to record the architectural recommendation for the enhancement.* *6. Problem Statement: Requires data with GIS data elements to be loaded from spreadsheet sources to a data store capable of handling the data and to be the System of Record for that data. There are a number of candidate systems of record, and 2 candidate GIS environments.* *This data is only 50 % complete at this time. Most CUSTOMER data has not been cleaned and authenticated but will be available shortly. About 70,000 rows of data will be identified.. System of record and update process needs to be established.* *In addition to CUSTOMER data, there is a need for other supporting data to be available for viewing in a spatial context. This supporting data is also discussed for architecture implications and a recommendation is made.* *7. Handling of Data Flow Design . Compare and contrast 2 GIS environments for GIS data elements, dimensions such as quality,*

	completeness, timeliness, elements of authenticity. *Compare and contrast the several data sources (non GIS)on dimensions such as quality, completeness, timeliness, elements of authenticity, enterprise standards maintained?* *Note existing business processes against each source, for rigor, inclusiveness (enterprise or departmental in scope), data stewardship.* *8. Issues : System of Record: discuss various candidate SOR* *9.Issues: Database deployment: Discuss where the proposed new database might be deployed, and how, including mandatory capability to handle GIS elements, distributed DB design, 7x24 availability,* *10. Issues- Modeling: combining several sources into a new SOR will need to generate a new system key, resolve duplicate records. Data cleaning must be performed by the Business.* *11. Alternative 1: . Data source x(non-GIS) & y(GIS) & ultimate new DB store looks like a* *- Diagram* *12. Alternative 2: Data source z(non-GIS) & y(GIS) & ultimate new DB store looks like a* *- Diagram* *"These are the only viable alternatives."* *13. Application Deployment;* *Data profiling will help establish the overlap of the various sources, and is recommended.* *Processes must be put in place to sustain the new db, and the data quality. Application management must be engaged to develop rudimentary input/update mechanism just for this purpose.* *14. Recommendation Recommendation* *Alternative 1 is recommended for the following reasons:* *15. Ongoing Deviation from Standard:* *Example* *a. Due to the need to store GIS data in the new DB store, the database recommended is xxx, proprietary in nature, Current principles point to non-proprietary DB stores as a standard. GIS product standard is currently xxx a 3rd generation GIS tool.*

	b. Due to the need for GIS elements to describe this SOR data, this business data SOR for CUSTOMER is recommended to be kept in a GIS db. This violates the current architecture principle to maintain all business data SOR in business side applications. Data feeds will be designed to keep downstream systems of propagation, which are the business systems using this data in sync with this SOR *Will review these ongoing deviations as a project input to new GIS tool implementation/upgrade.*
Work Product Assessment	**WORK PRODUCT 12.101: PURPOSE & SCOPE** 3=meets expectation 2= partial 1=poor 0=nothing Explain responses less than 3

#	Item	Score	Review
1	All participants agree that the purpose is clearly stated and will sign the document	*3*	
2	What is in/out of scope is clearly stated	*3*	
3.	More than one alternative presented, and alternatives are complete, clear and well developed	*3*	
4	Recommendation is clear ,concise and actionable,	*3*	
5.	Outstanding issues noted, with reasons why there is a continuing non-compliance, and what future plans if any will address	*3*	
6	Supporting dependencies are clearly indicated	*3*	
Average Score		*3.0*	

Template Assessment	**Template 12.101: Assessment Document**			
	Assessor:			
	Date: *July 8, 2006*			
	#	Score	Question	Comment
	1	3	The template carries out the task I was expecting to see	
	2	2	Template directions are written clearly	*Scope directions did not call for identifying potential "not in scope" elements.*
	6	2	The template is complete as it stands	*Should project risk factors and risk mitigation be considered in this document?*

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