EVMS Maturity Assessment Tool Development Process

Integrated Project/Program Management (IP2M)
Maturity and Environment Total Risk Rating (METRR)
using Earned Value Management System (EVMS)

Report No. 4, Annex A

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Executive Summary

This research report summarizes the efforts of the research team to develop the Earned Value Management System (EVMS) maturity assessment tool, one of the two components of the Integrated Project/Program Management (IP2M) Maturity and Environment Total Risk Rating (METRR). The authors in conjunction with the research team and using an extensive literature review, developed a set of 56 maturity attributes to assess the EVMS maturity. The authors hosted a series of four industry workshops where 56 industry professionals, representing 32 unique organizations as listed in Appendix A, evaluated the maturity attribute names, descriptions, and the narratives of the different maturity levels. The workshop participants provided comments, and weighted (prioritized) the maturity attributes and sub-processes as elaborated in this report. The authors and the research team addressed the comments, and the collected data was statistically analyzed and used to develop weighted score sheets as a mechanism for maturity assessment.

This document is part of the deliverables for the research project sponsored by the DOE and has been approved by the research steering committee and Arizona State University (ASU) joint team.

The IP2M METRR is a novel assessment mechanism developed as part of a DOE-sponsored Joint Research Study led by ASU and representing 19 government, industry, and academic organizations. The research team members are 41 individuals who have a diverse background including owners, contractors, consultants, academia, and so forth. The list of the research team members is provided at the end of this document. The tool assesses a spectrum of EVMS maturity and environment issues centered around the EIA-748 EVMS Guidelines, while also referencing the Project Management Institute's American National Standards Institute (ANSI) standard for EVM (2019) and International Organization for Standardization (ISO) 21508:2018 guidance. By using the IP2M METRR (pronounced "IP2M meter") to assess both the maturity and environment of an EVMS, project leaders and personnel can understand the efficacy of that EVMS to support integrated project/program management. It also helps identify opportunities for improvement. The goal of performing this assessment is to assure project/program participants are working with accurate, timely, and reliable information to manage their work, leading to successful project/program performance.

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1. Background

The *Integrated Project/Program Management (IP2M) Maturity and Environment Total Risk Rating (METRR) using EVMS* is an assessment mechanism being developed as part of a DOE-sponsored Joint Research Study led by the Arizona State University (ASU). The tool can help project/program teams assess the maturity and environment of an EVMS application. The basis of this development effort was an extensive literature review and an industry survey as reported in other reports.

This research report summarizes the efforts of the research team to develop the assessment component used for assessing EVMS maturity. The authors, in conjunction with the research team, developed a set of 56 draft maturity attributes to be used to assess EVMS. The authors hosted a series of four separate industry workshops where 56 industry professionals evaluated the maturity attribute names, descriptions, and the narratives of the different maturity levels. The list of the 32 unique organizations that these professionals represented are given in Appendix A. The workshop participants provided comments, weighted (prioritize) the EVMS maturity attributes and sub-processes as elaborated in this report. The authors addressed the comments, and the collected data was statistically analyzed and used to develop weighted score sheets that can be used to assess the maturity of EVMS.

2. Methodology

This section outlines the methodology employed for developing EVMS assessment draft and producing the IP2M METRR score sheets. The research methods of data collection and statistical data analysis procedures are described in this section. Figure 1 provides a logic flow diagram of the research methodology, providing a visual representation of the steps undertaken by the authors.

The IP2M METRR tool includes two main sections: maturity and environment. This report will provide the methodology adapted for the maturity assessment section. Further details on environment assessment methodology and development of EVMS environment score sheets, as shown in Figure 1, is discussed in a separate research report (research report #3, Annex A).
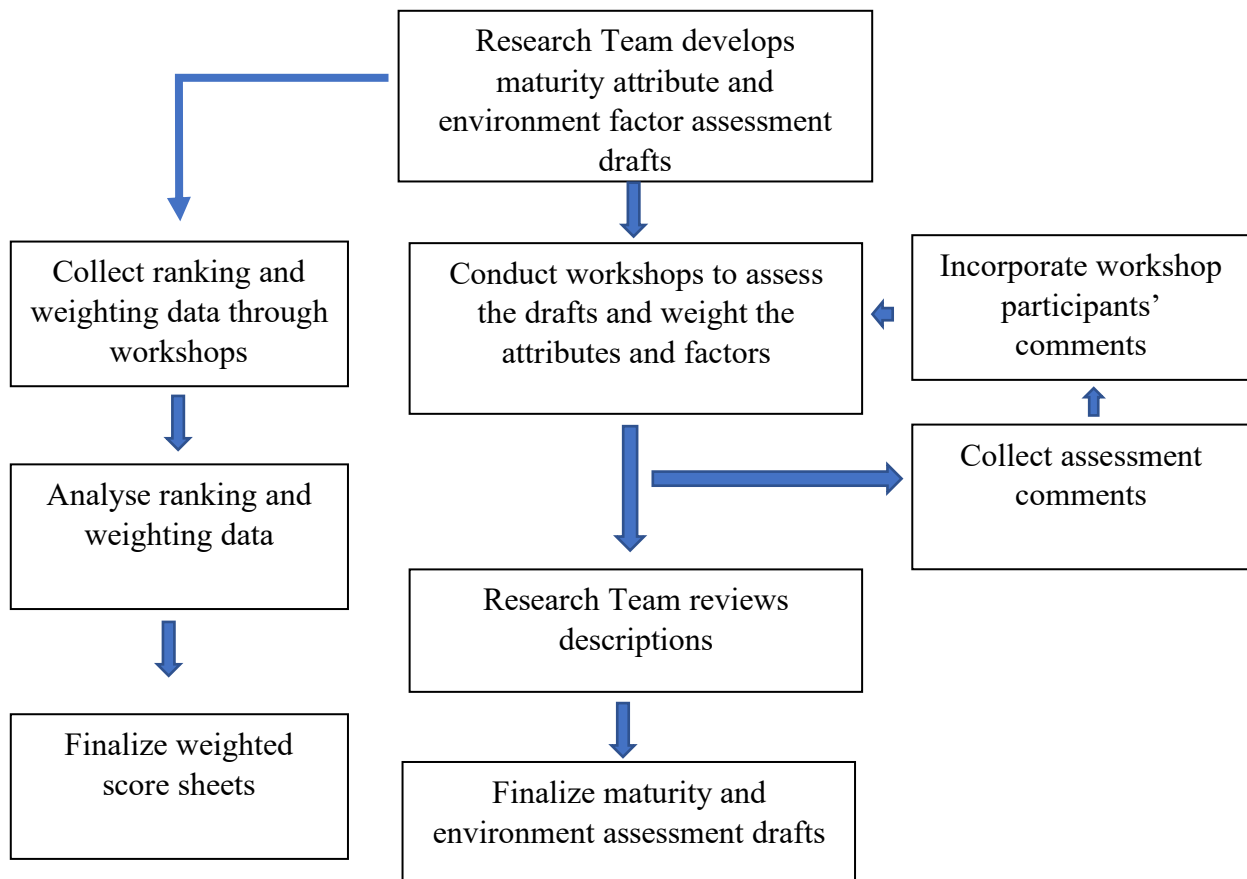
Figure 1 Research Methodology Flow Chart

The research team conducted multiple of meetings to develop the EVMS maturity attribute assessment drafts including their descriptions and the draft score sheets. Workshops were conducted to collect comments on the assessment drafts and develop weights to be used in score sheets. The authors used statistical methods to analyze the data collected in the workshops.

The maturity assessment draft includes a structured list of descriptions detailing specific attributes that should be addressed during EVMS maturity evaluation, and a weighted score sheet that corresponds to each attribute. The purpose of the weighted score sheet is to quantitatively gauge the maturity level of each maturity attribute from Low to High. The following chapters lay out how this tool was developed and its final form.

3. Development of EVMS Maturity Assessment Draft

The research team identified 56 attributes critical to EVMS maturity that make up the ten EVMS sub-processes (Organizing, Planning and Scheduling, Budgeting and Work Authorization, Accounting Considerations, Indirect Budget and Cost Management, Analysis and Management Reporting, Change Control, Material Management, Subcontract Management, and Risk Management). Research team members included 27 government and industry professionals who are experts in EVMS (original research team members). Research team members are provided in Appendix L at the end of this report.

The attributes are mainly derived from the EIA-748 guidelines that are distributed among the ten EVMS sub-processes as per Figure 2 (NDIA 2020; NDIA 2018; SAE 2019), while also referencing the Project Management Institute's American National Standards Institute (ANSI) standard for EVM (2019) and International Organization for Standardization (ISO) 21508:2018 guidance (PMI 2019; ISO 2018). The arrangement into sub-processes places common attributes together for ease of discussion during EVMS maturity assessments.
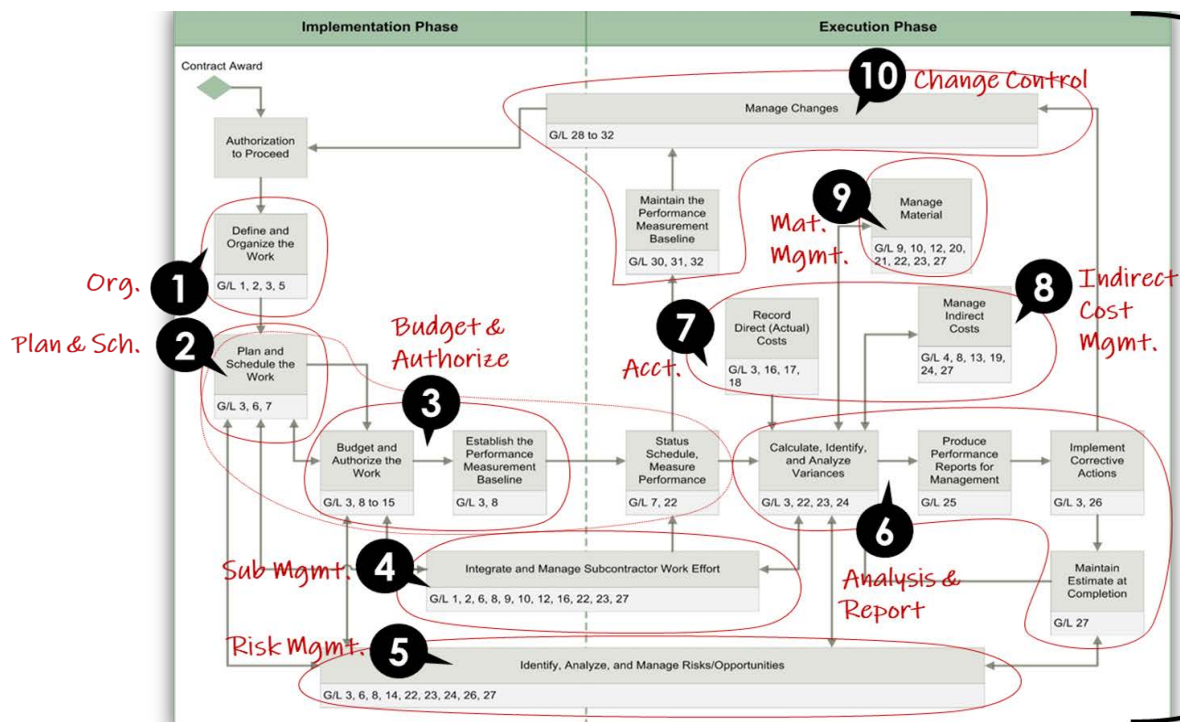
Figure 2 EVMS Process Diagram (NDIA 2020)

Each attribute also has a detailed narrative that provides description of the attribute (i.e., attribute description), as well as narratives for each level of maturity. An example is shown in Table 1.

The descriptions were drafted by the research team using the collected guidelines and standards that pertain EVMS from the literature (DoD 2020; GAO 2020; McGregor 2019; PMI 2019; SAE 2019; DOE 2019; DOE 2018; ISO 2018; NDIA 2019a; NDIA 2019b; NDIA 2018; DoD 2015; DOE 2015; GAO 2015; DoD 2012; OMB M-07-24 2007). The particular list of the references of each attribute are shown in its corresponding table (e.g., Table 1).

Table 1 Example Attribute Description from IP2M METRR – Organizing Process, Attribute A.1

SUB-PROCESS A: ORGANIZING		Maturity Level			
	LOW	MEDIUM			HIGH
A.1. Product-Oriented Work Breakdown Structure (WBS)	1	2	3	4	5
A product-oriented Work Breakdown Structure (WBS) is developed for a given project and extended to the control account level, as a minimum, and lower levels (e.g., work package/planning package) as necessary for management control. A WBS displays and defines the products, and/or services, to be developed and/or produced. It is a product structure and not an organizational structure. Only one WBS exists. A WBS is a decomposition of all the work necessary to complete all authorized project scope including any revisions resulting from authorized changes and modifications. It uses nouns and adjectives to define work and is arranged in a hierarchy. It is constructed to allow for clear and logical groupings, either by activities or deliverables. The WBS should represent the work identified in the approved Project Scope Statement or Statement of Work (SOW)/Statement of Objectives (SOO) and serves as an early foundation for effective schedule development and cost estimating and map to the authorization documentation. Programs typically will develop a WBS as a precursor to a detailed project schedule. The WBS is accompanied by a WBS Dictionary, as required, which lists and defines WBS elements. The goals of developing a WBS are to define the work elements 1) for the project team to proactively and logically plan out the project to completion, 2) to collect the information about work that needs to be done for a project, 3) to organize activities into manageable components that will achieve project objectives, 4) facilitates data collection and traceability, and 5) provides a control framework for integrated project/program management. The number of levels of the WBS should be determined by management needs, project/program risk and complexity, and similar driving factors. Items to consider include: Singularity of Work Breakdown Structure (WBS) WBS tied to the project/program SOW/SOO Traceability matrix (e.g., SOW, design requirements and build specifications) to WBS WBS reflects base contract and modifications WBS descriptive documents, such as a WBS dictionary, index, or similar document(s), that reflect and expand on the contract SOW/SOO Work Authorization Documents (WADs) based on the dictionary pages (optional) Other The WBS should be integrated with the Planning and Scheduling sub-process, Budgeting and Work Authorization sub-process, Change Control sub-process, Accounting Considerations sub-process, and Analysis and Management Reporting sub-process. *References:* NDIA EVMS EIA-748-D Intent Guide GL 1; DoD EVMSIG GL 1; DOE CAG GL 1; EIA748-D; NDIA PASEG; MIL STANDARD 881 Rev E; ISO 21508:2018(E); ANSI PMI 19-006-2019	**Not yet started.**	**A singular, high-level product-oriented WBS is established. WBS does not decompose to capture all work requirements.** The process to establish a singular, product-oriented WBS has started, but is not documented. The hierarchical WBS is not fully traceable to the SOW and is missing SOW scope. The WBS is functionally oriented and lacks product orientation. Products often do not fulfill project/program requirements.	**Processes to require a singular, product-oriented WBS are established. WBS is traceable, and decomposed to the appropriate levels for effective project/program management. The WBS includes most of the authorized work scope / requirements.** The process to establish a singular, product-oriented WBS that accurately reflects the products, services, and deliverables required to complete the project/program has been developed. No internal checks are in place to validate that the WBS meets requirements. Most products fulfill project/program requirements. The WBS hierarchy initially is product-oriented, but the WBS as extended to lower levels becomes functionally oriented in an organizational or functional orientation. The WBS is coordinated with the Planning and Scheduling sub-process, Budgeting and Work Authorization sub-process, Change Control sub-process, Accounting Considerations sub-process, and Analysis and Management Reporting sub-process.	**Processes requiring a singular, product-oriented WBS are established and approved. WBS is traceable, encompassing all authorized work and decomposed to the appropriate levels for effective project/program management and external reporting. The required WBS is validated through internal checks per approved processes annually.** The process to establish a singular, product-oriented WBS that accurately reflects the products, services, and deliverables required to complete the project/program has been developed, documented and approved. Internal checks are in place to validate that the WBS meets project/program requirements. Checks may be outside the WBS process flow. The project/program ensures that the WBS is verified as product-oriented, with corrections performed as required during project/program start-up. Products fulfill all project/program requirements. If required, WBS descriptive documents such as a WBS dictionary, index, or similar document(s) have been developed. The WBS is fully integrated with the Planning and Scheduling sub-process, Budgeting and Work Authorization sub-process, Change Control sub-process, Accounting Considerations sub-process, and Analysis and Management Reporting sub- process.	**The singular product-oriented WBS is reviewed, revised and validated annually or more frequently as needed, with revision history, per approved processes, through in-process internal checks.** The WBS is optimized to streamline management of the project/program. Internal checks are in place to validate that the WBS meets project/program requirements within the WBS process flow. Automated testing ensures that the established WBS is a product-oriented hierarchical decomposition of hardware, software and services. Necessary corrective actions are implemented, completed, and recurring issues resolved. Routine surveillance results of the WBS are fully disclosed with all key stakeholders, who maximize use of these results. The WBS is continuously improved and optimized.

Note that the total number of attributes in this tool is 56. The authors and research team started with a list of 82 attributes, which grew to over 100 (when considering all guidelines from the EIA-748 Intent Guide, attributes from the DOE EVMS measurement process tests, the DoD's EVMSIG documents, and so on), but the list was whittled down and combined to make up the final 56 based on a rigorous process that included focus group discussions and expert input over several months, in an effort to streamline and reduce the complexity of assessments. Most of the changes occurred because of attribute redundancy and the ability to combine similar and closely-related concepts. For example, the attribute dealing with indirect budgets being managed and incorporated into the PMB was combined with the attribute dealing with indirect budgets being established and projected based on published rates for each organization, to make a more comprehensive attribute for indirect budgets.

The authors, along with help from the research team, organized four workshops where 56 EVMS practitioners provided comments on assessment draft, with many who weighted (prioritized) the attributes under each sub-process based on each attribute's relative impact on the maturity of the sub-process, and weighted (prioritized) the ten sub-processes based on the relative impact of each sub-process as related to overall EVMS maturity. The authors used Qualtrics to administer and collect the responses of the participants. The workshops were held online via ZOOM for safety measures considering COVID-19 pandemic.

Details of these workshops are shown below:

07/09/20	Maturity Workshop #1	3.5 hours	12 participants
08/05/20	Maturity Workshop #2	3.5 hours	13 participants
11/05/20	Maturity Workshop #3	3.5 hours	13 participants
11/17/20	Maturity Workshop #4	3.5 hours	18 participants

A sample Qualtrics questionnaire used in the workshops is provided in Appendix B. Each maturity attribute in the IP2M METRR was given a not applicable (N/A) level and five potential levels of assessment (see Table 2). The following levels were used by participants to assess each EVMS maturity attribute on the project/program.

Table 2 EVMS Maturity Attribute Assessment Levels

N/A	1	2	3	4	5
Not Applicable	Not Yet Started	Major Gaps	Minor Gaps	No Gaps	Best in Class

The workshop participants allocated 100 points divided among the attributes under each sub-process, based upon their perception of each attribute's relative impact on the maturity of the sub-process; they were also asked to allocate 100 points divided among the ten sub-processes based on their perception of the relative impact of each sub-process as related to overall EVMS maturity. In both cases, they were asked to allocate more points for more important attributes, and sub-processes. The next section provides more details on the workshop process.

4. EVMS Maturity Workshop Process

The authors facilitated each of the workshop sessions hosted online using the Zoom platform. All confirmed workshop participants were sent information packets electronically prior to each session; these included background information about the research study and the purpose of the workshop itself. Similar information packets were sent out prior to all of the workshop sessions. Potential workshop participants were asked to review all of the "pre-read' information prior to the workshop sessions, which included familiarizing themselves with the EVMS maturity assessment draft, and workshop presentation. The presentation included an agenda for the session, instructions for evaluating the EVMS maturity draft, including allocating importance points on maturity attributes and sub-processes.

Each session began with a Microsoft PowerPoint presentation (a sample presentation is included in Appendix C) that briefly described the objectives of the workshop, background of the research project, background of the IP2M METRR, and instructions for evaluating the assessment draft. During that presentation, participants were provided the Qualtrics url link containing the Workshop questionnaire and then collectively guided through how to fill it out (Appendix B).

Using Qualtrics as the data collection mechanism, the participants were first asked to provide information about an anchor project or program, which is a sample project or program they have worked on previously, or are working on now, that would be used as reference throughout the workshop session; essentially this would be their mind's focus when thinking about EVMS maturity assessment. After that information was provided, each of the EVMS maturity attributes were reviewed, one by one. However, due to the time limitation of each workshop, participants were asked to continue assessing the remaining attributes after the session and within a couple of days voluntarily, if possible: The participants of the first and the third workshops reviewed 31 attributes together in the workshop session (attributes that make up sub-processes A to D) and were asked to review the remaining 25 attributes afterwards (attributes that make up sub-processes E to J). The participants of the second and the fourth workshops reviewed 25 attributes together in session (attributes that make up sub-processes E to J) and were asked to review the remaining 31 attributes afterwards (attributes that make up sub-processes A to D).

It was noted that some maturity attributes might not be applicable to the anchor projects being referenced by the participants. Non-applicable attributes were described as attributes that truly would not need to be assessed in a project/program EVMS. Participants were instructed to identify an attribute as not applicable (i.e., N/A) when providing comments on each attribute, and then not weight it (provide zero point of relative importance).

The facilitators addressed any questions posed by the workshop participants as the attributes were individually reviewed. Adequate time was provided for participants to assess each attribute, but not enough time to "over think" the attributes, keeping a consistent flow and timing throughout the session. Following the review of the maturity attribute descriptions for each sub-process, the facilitator asked each participant to weight the attributes within that sub-process relative to each other.

For example, the question focused on sub-process A (Organizing) stated "This question is focused on the attributes that make up the Organizing Sub-process (Sub-process A). Please allocate 100 points divided among the attributes below, based on each attribute's relative

impact on the maturity of the Organizing Sub-process (Sub-process A). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100." An example of the response received by a given participant to this question during the workshop is provided in Figure 3.

A.1 Product-Oriented Work Breakdown Structure (WBS)	___20___
A.2 Work Breakdown Structure (WBS) Hierarchy	___20___
A.3 Organizational Breakdown Structure (OBS)	___35___
A.4 Integrated System with Common Structures	___5___
A.5 Control Account (CA) to Organizational Element	___20___
Total:	100

Figure 3 Example Maturity Attribute Collected Response

After completing the review of all descriptions and the weighting, the participants were asked to weight the sub-processes one versus the other, based on relative importance. The question on weighting the sub-processes stated "This question is focused on the relative importance of the ten sub-processes that typically make up an EVMS. Please allocate 100 points divided among these sub-processes based on the relative impact of each process as related to overall EVMS maturity. When weighting, think about your anchor project/program and allocate percentages accordingly. Allocating more points to a sub-process reflects a higher impact on EVMS Maturity. The total number of points should sum up to 100." An example of the response received by a given participant to this question during the workshop is provided in Figure 4.

A. Organizing Process (WBS; WBS Hierarchy; OBS; Integrated System; CA to Organizational Element)	___20___
B. Planning and Scheduling Process (Time-Phased Work Scope; Schedule; Horizontal and Vertical Integration; IMS Resources; Schedule Detail; CP and Float; SM; Progress Measures; PMB)	___20___
C. Budgeting and Work Authorization Process (Alignment of Scope, Schedule, Budget; SLPPs; WADs; Budgeting by EOC; WP; Units and Budget Substantiation; EVTs; LOE; Identify MR; UB; Reconcile Target Cost Goal)	___20___
D. Accounting Considerations Process (Direct Costs; Actual Cost Reconciliation; WPs; Direct Cost Breakdown Summary)	___5___
E. Indirect Budget and Cost Management Process (Indirect Account; Indirect Budget and Cost; Indirect Variance Analysis)	___5___
F. Analysis and Management Reporting Process (Calculating Variances; Variances to CAs; Performance Measurement Information; Management Analysis and Corrective Actions; EAC)	___10___
G. Change Control Process (Control MR and UB; Incorporate Customer Directed Changes; Baseline Changes Reconciliation; Control Retroactive Changes; Unauthorized Revisions to CBB)	___10___
H. Material Management Process (Recording Actual Material Costs; Material Performance; Residual; Price/Usage Variance; Unit Costs and Lot Costs)	___3___
I. Subcontract Management Process (Identification and Requirements Flow Down; Integration and Analysis; Oversight)	___2___
J. Risk Management Process (Identify, Analyze, and Manage Risk; Risk Integration)	___5___
Total:	100

Figure 4 Example Maturity Sub-Process Response

During the workshops, the industry practitioner volunteers were also asked to provide feedback regarding the maturity attribute descriptions. As discussed earlier, the authors used Qualtrics during the workshops to collect data. Each participant could also record additional thoughts concerning the workshops or overall EVMS maturity assessment. The authors reviewed all the collected comments collected and revised the attribute descriptions with the support of the entire research team.

The feedback requested during the workshops were used to improve the maturity assessment draft that contained the list of 56 maturity attributes with their descriptions and narratives. The list of attributes is shown in Appendix D. Workshop 1 received 206 comments that were addressed by the authors and the research team to edit the maturity assessment draft and then allowed the author's use of the improved draft version for Workshop 2. Workshop 2 received 305 comments that were also addressed by the authors and the research team. The total number of comments received by workshops 1 and 2 was 511. After addressing these comments, the research team edited the maturity assessment draft, which was used in the next two workshops. Workshop 3 and 4 received 200, and 148 comments respectively. The final assessment form draft was finally generated by addressing all these comments. Therefore, all the 859 comments received through the four workshops from 56 participants were resolved to produce the final version of maturity assessment draft.

The workshops were remarkably successful in both collecting data and receiving insight from experienced industry professionals on the value and use of the tool. They also allowed the researchers to effectively and efficiently collect data to improve the tool and generate score sheets. The following sections discuss the results and describes the process to generate the final score sheets.

5. Results, Data Screening, and Analysis

This chapter outlines the results of data obtained during the four maturity workshops, and how input obtained from these workshops was used to develop the final EVMS maturity score sheets, after screening the data for reliability. This section briefs the data analysis processes.

The authors followed the processes shown in Figure 5 to perform the analysis.
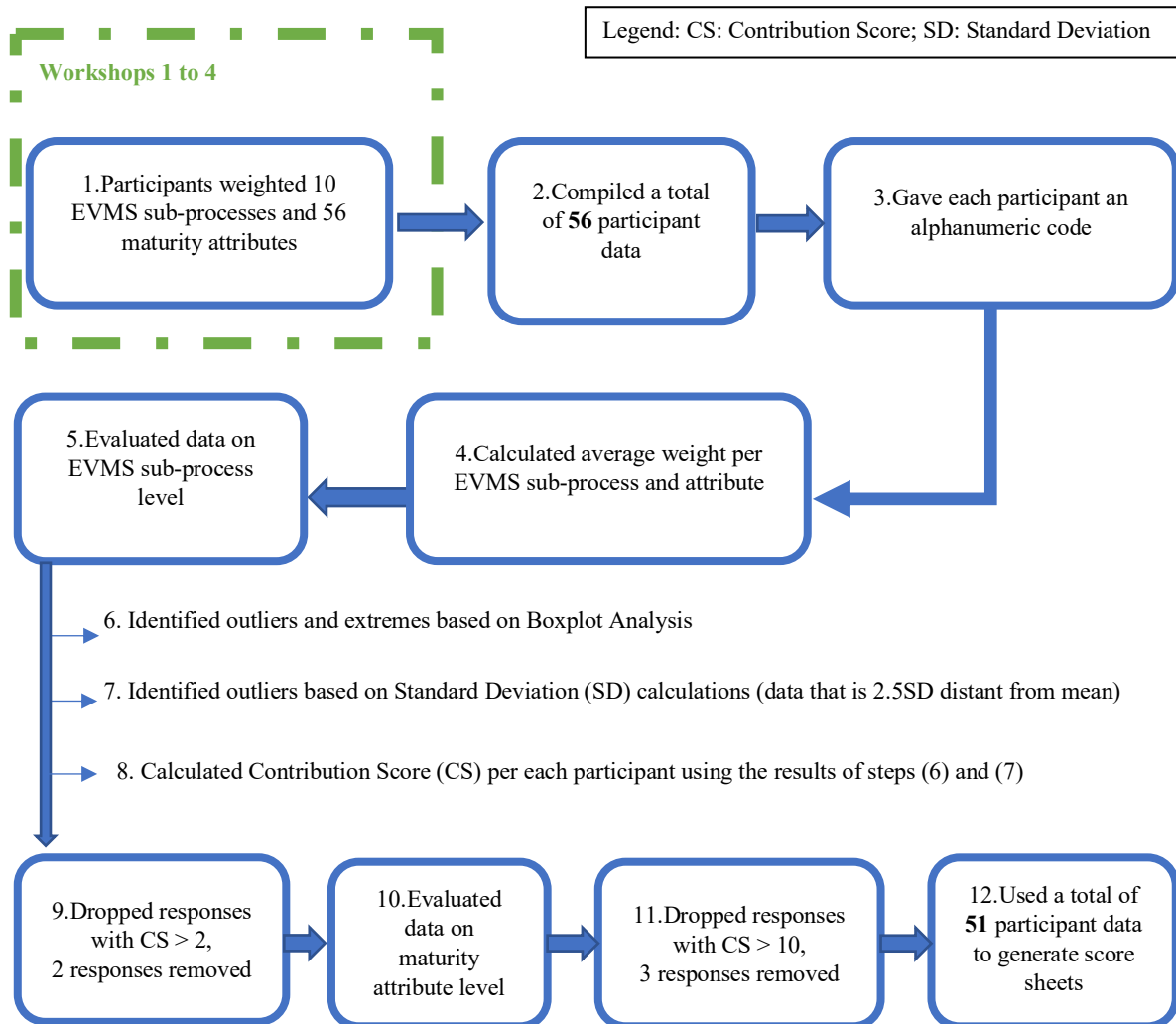
Figure 5 Data and Outlier Analysis Process

The details of each process for compiling the data after weights were collected from the workshops, calculating the average weights, performing outlier analyses, and generating the final score sheets are given in the next sections.

5.1. Developing EVMS Maturity Attribute Weights

Compiling data

The weighting data from the workshop participants was compiled into one Microsoft Excel spreadsheet. Each participant was given an alphanumeric code based on the workshop in

which they participated in order to protect confidentiality and limit bias from the researchers. For example, MWS2-4 stands for the Maturity Workshop 2, and last digit (4) denotes participant number 4.

Fifty-six participants participated in the four maturity workshops, however not all of them weighted all the EVMS sub-processes and attributes. The questions in the Qualtrics survey requesting weighting data (Figures 3 and 4) were not forced-choice questions, meaning that a respondent can skip any of the questions related to weighting the different attributes and sub-processes. Also, since a remaining portion of the 56 attributes was requested to be assessed after the end of the workshop due to the time limitation of each workshop (as explained earlier in section 4) and within couple of days voluntarily, many participants could not carry out this request. For example, participant MWSP3-4 weighted the different maturity attributes that make up the sub-processes A to D, yet did not provide weighting data for the attributes that make up the sub-processes E to J. Therefore, the number of participants or responses N (sample size) providing data on the different maturity attributes that make up each sub-process was different for each sub-process. Regarding the question on weighting the ten sub-processes based on relative importance (Figure 3), the compiled data had eight missing responses, out of the 56 responses, i.e., a sample size of N=48. Overall, the number of participants or responses N corresponding to each of the attributes making up the different sub-processes, and the ten sub-processes are shown in Table 3 (before performing any outlier analysis, as elaborated later).

Table 3 Number of Responses (N) Received on Weighting the EVMS Sub-processes and Attributes

	Sub-process Weights	Attribute Weights									
		A	B	C	D	E	F	G	H	I	J
N =	48	37	35	34	33	50	49	46	46	47	46

Calculating average weights

The weights received from the workshops were put into a Microsoft Excel spreadsheet. Then, an average weight (percentile) was generated for all attributes and sub-processes following equation (1):

Equation (1): Average Weight per attribute or sub-process:

$$\overline{x_n} = \frac{\sum_{i=1}^{n} x_i}{N} (1)$$

$\overline{x_n}$: Average attribute or sub-process weight (in %)
x_i: Weights received by all participants for each attribute or sub-process
N: Total number of participants who weighted each attribute or sub-process

All the average weights for each attribute under a given process sum up to 100. Also, all the average weights for all the ten EVMS sub-processes sum up to 100. Figure 6 gives an example of equation (1) application: calculating the average weight of each attribute.

Attribute A.1 (Product-Oriented Work Breakdown Structure) received a total weight of 845 by 37 participants.

Applying Equation (1) results into the attribute's average weight, which is 22.8 (845/37).

Figure 6 Example Attribute A.1 Average Weight

This was done for all the 56 maturity attributes and ten EVMS sub-processes. Sample results of this step are shown in Appendix E.

Screening the data

The authors sought to perform a quality control of the dataset in order to include those data inputs that were reasonably representative of the overall sample and exclude the outliers or extremes lying far from the majority (Kwak and Kim 2017; DeSimone et al, 2015; Dixon 1953). In this way, the final weightings would be more representative of the collective whole. The screening was done first at the higher EVMS sub-process level, and then on a lower maturity attribute level. The authors utilized Statistical Product and Service Solutions (SPSS) and Microsoft Excel to perform the tasks for screening the data, and calculate the descriptive statistics (e.g., mean, median, standard deviation, variance, skewness) of the data. Analysis of descriptive statistics revealed that several of the sub-processes and the attributes were either moderately or highly skewed, indicating that responses from several of the participants were skewing the overall data set. The following process was used to assess the respondents.

Step 1 Evaluate the EVMS sub-process weighting (higher-level)

As previously discussed, participants were asked to weight the ten EVMS sub-processes, based on the relative impact of each sub-process as related to overall EVMS maturity, by allocating 100 points divided among these ten sub-processes based on their perception of relative importance in relation to overall maturity impact. Forty-eight of 56 workshop participants had provided input to this request, as explained earlier. Therefore, the authors assessed the data that came from the 48 respondents in this subsection when evaluating the EVMS sub-process weighting data (higher-level) in Step 1.

In this step, the authors generated boxplots in SPSS to analyze the collected weights of each EVMS sub-process. Boxplots are commonly used for graphically summarizing the distribution of a dataset (Morrison 2009). A typical boxplot is represented in Figure 7 below (outliers are shown as circles and extreme values as *) and is used to detail the interquartile range, median, outliers and extreme values (Morrison 2009).
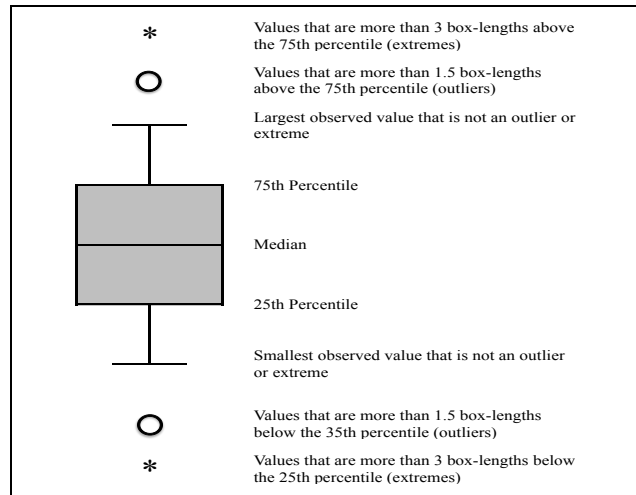
Figure 7 Sample Boxplot

As shown in Figure 7,

A data point is considered an outlier value (X) if:

$$X < (Q1 – 1.5\ IQR)\ or\ X > (Q3 + 1.5\ IQR)$$

Where:
Q1 = 25th percentile value
Q3 = 75th percentile value
IQR = Interquartile range = Q1 – Q3

A data point is considered an extreme value (Y) if:

$$Y < (Q1 – 3\ IQR)\ or\ Y > (Q3 + 3\ IQR)$$

Where:
Q1 = 25th percentile value
Q3 = 75th percentile value
IQR = Interquartile range = Q1 – Q3

The results of the boxplots for the ten EVMS sub-processes are shown in Figure 8, detailing the outliers, and the extreme values (if any) and allowing to visually identify participant weights that were skewing the mean sub-process weights. The sub-processes on the boxplots are rearranged based on lowest to highest medians (left to right). The sample descriptive statistics of the workshop EVMS sub-process weighting data are shown in Appendix F.
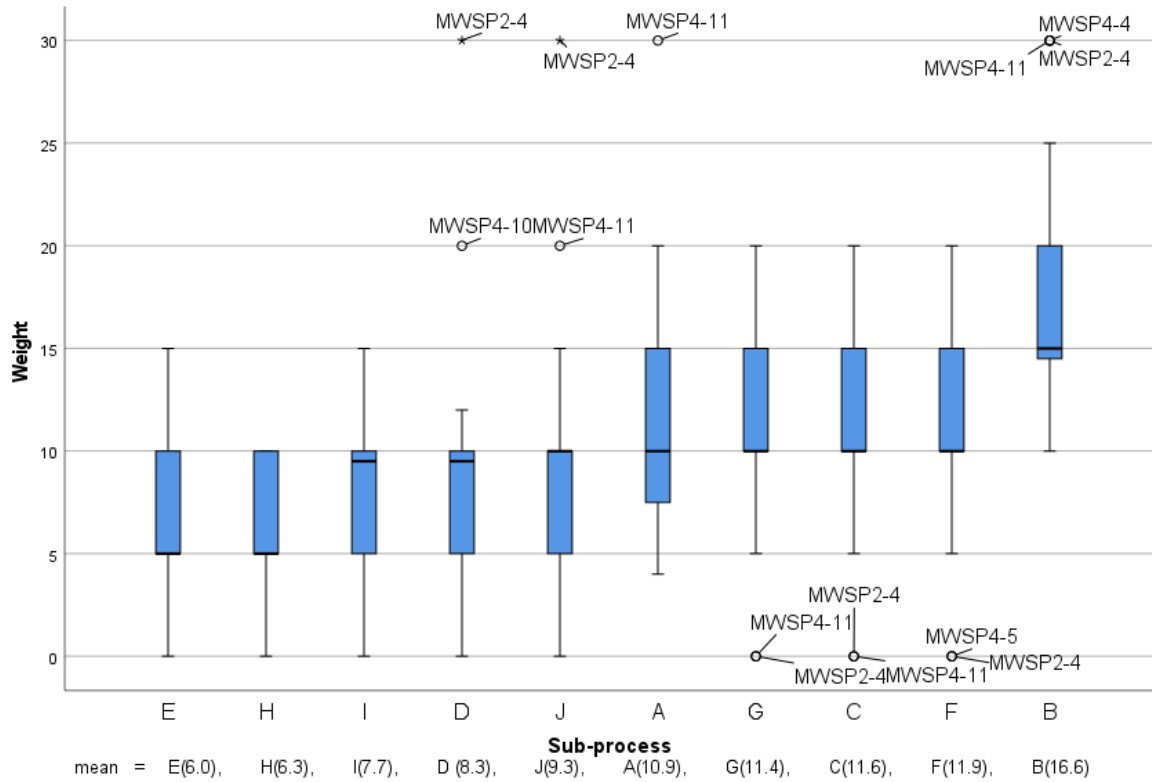
Figure 8 Sub-process Weight Boxplot – Workshop Results – N =48

Based on the results in Figure 8, there has been two extremes identified by one participant, and twelve outliers have been identified and were provided by five participants. The list of the participants divided by sub-process and their number of outliers and extremes are shown in Table 4.

Table 4 Sub-process Outliers and Extremes based on Boxplots – N =48

Sub-process	Participant	# of sub-process outliers:	# of sub- process extremes:
A	MWSP4-11*	1	
B	MWSP2-4**	3	
	MWSP4-4		
	MWSP4-11*		
C	MWSP2-4**	2	
	MWSP4-11*		
D	MWSP2-4**		1
	MWSP4-10	1	
E	None		
F	MWSP2-4**	2	
	MWSP4-5		
G	MWSP2-4**	2	
	MWSP4-11*		
H	None		
I	None		
J	MWSP2-4**		1
	MWSP4-11*	1	
Total		12	2
Note: *, ** Same participant			

Next, the authors utilized Microsoft Excel to derive each sub-process's mean and the standard deviation (SD). Then each sub-process weight given by a participant was expressed as a function of the calculated standard deviation. As such, the authors could highlight the participant-given sub-process weights that are 2.5SD distant from the sub-process mean. Figure 9 gives an example for calculating the sub-process weights as a function of SD.

Sub-process A's weight given by the workshop participant MWSP4-11 is 30.00 (out of 100 points).

Whereas the sub-process mean and standard deviation are 10.88 and 4.99, respectively.

The distance of the provided weight is 19.12 from the mean (30.00-10.88).

This distance is expressed as a function of the standard deviation as 3.83SD (19.12/4.99).

Figure 9 Example Sub-process Weight as a Function of SD

See the sample detailed results of this step applied to sub-process A in Appendix G. In total, 10 weights have been identified as 2.5SD distant from sub-process weight mean. These results were needed to calculate the "contribution scores" elaborated next.

Then, following the same approach of ElZomor et al. (2016), the authors calculated sub-process "contribution scores" (i.e., the amount a participant was skewing the data) for each workshop participant based on the number of outliers, extremes and whether their weight was 2.5SD distant from mean. The contribution scores (unitless) were calculated as follows (ElZomor et al. 2016):

<u>Equation (2): Contribution Score:</u>

Contribution score per participant =

1× (Number of Extremes in all sub-processes) + 1× (Number of Outliers in all sub-processes) + x

Where, x =
$$\begin{cases} 1, \text{ if weight is 2.5SD distant from mean in 1 sub-process} \\ 2, \text{ if weight is 2.5SD distant from mean in more than 1 sub-process} \\ 0, \text{ otherwise} \end{cases}$$

Equation (2) contributes to viewing where each participant's response stands with respect to the combination of the following settings: (1) whether the response is an outlier based on boxplot analysis, (2) whether the response is distant from mean within only one sub-process out of the ten EVMS sub-processes, and (3) whether the response is distant from mean within more than one EVMS sub-process. Table 5 shows each workshop participant's contribution score by applying the equation (2) for each participant. The participants whose responses resulted into a contribution score of greater than 0 are highlighted in yellow in Table 5, except for 7 and 8,which are highlighted in light red. Viewing the weighting data in this fashion highlighted the contribution score ranges skewing the mean sub-process weights the most, and ranges of scores that were relatively higher than the total workshop participant set.

Table 5 Workshop Participant Sub-process Contribution Scores – N =48

Workshop Participant	# of Outliers in all sub-processes	# of Extremes in all sub-processes	x	Contribution Score	Workshop Participant	# of Outliers in all sub-processes	# of Extremes in all sub-processes	x	Contribution Score
MWSP1-1	0	0	0	0	MWSP3-3	0	0	0	0
MWSP1-2	0	0	0	0	MWSP3-4	0	0	0	0
MWSP1-3	0	0	0	0	MWSP3-5	0	0	1	1
MWSP1-4	0	0	0	0	MWSP3-6	0	0	0	0
MWSP1-5	0	0	0	0	MWSP3-7	0	0	0	0
MWSP1-6	0	0	0	0	MWSP3-8	0	0	0	0
MWSP1-7	0	0	0	0	MWSP3-9	0	0	0	0
MWSP1-8	0	0	0	0	MWSP3-10	0	0	0	0
MWSP1-9	0	0	0	0	MWSP3-11	0	0	0	0
MWSP1-10	0	0	0	0	MWSP3-12	0	0	0	0
MWSP1-11	0	0	0	0	MWSP3-13	0	0	0	0
MWSP2-1	0	0	0	0	MWSP4-1	0	0	0	0
MWSP2-2	0	0	0	0	MWSP4-2	0	0	0	0
MWSP2-3	0	0	0	0	MWSP4-3	0	0	0	0
MWSP2-4	4	2	2	8	MWSP4-4	1	0	0	1
MWSP2-5	0	0	0	0	MWSP4-5	1	0	1	2
MWSP2-6	0	0	0	0	MWSP4-6	0	0	0	0
MWSP2-7	0	0	0	0	MWSP4-7	0	0	0	0
MWSP2-8	0	0	0	0	MWSP4-8	0	0	0	0
MWSP2-9	0	0	0	0	MWSP4-9	0	0	0	0
MWSP2-10	0	0	0	0	MWSP4-10	1	0	1	2
MWSP2-12	0	0	0	0	MWSP4-11	5	0	2	7
MWSP3-1	0	0	0	0	MWSP4-12	0	0	1	1
MWSP3-2	0	0	0	0	MWSP4-13	0	0	0	0

Note: contribution scores greater than 0 are highlighted in yellow, except for 7 and 8, which are highlighted in light red.

In total seven participants, out of forty-eight, showed responses that resulted into a contribution score of more than 0. The team determined that workshop participants with a contribution score greater than two should be removed from the data set. This was a logical conclusion based on looking closer to the combination of distance from mean and having outliers and extremes on boxplot. Therefore, data sets from two workshop participants (MWSP2-4, MWSP4-11) were removed from the total data set. Figure 10 shows the results of the average sub-process weights, after the removal of the two data sets.
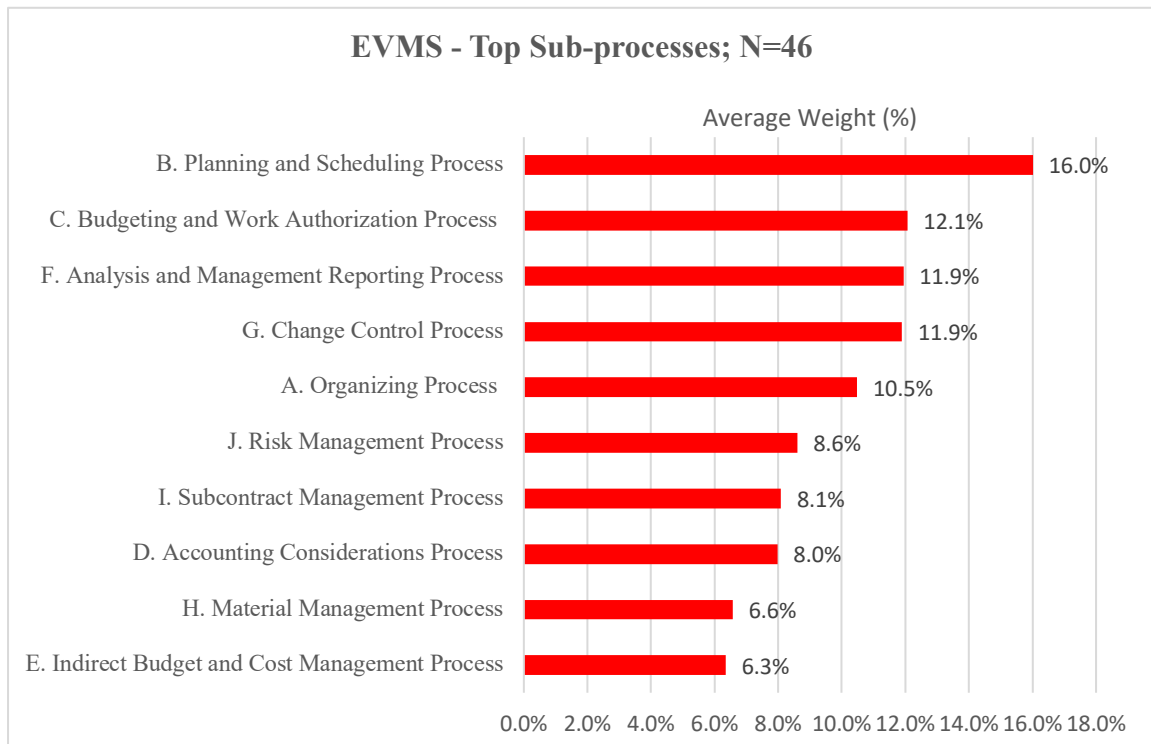
Figure 10 EVMS Sub-process Average Weight Results After Removal of 2 Outliers – N=46

As previously discussed, not all the workshop participants provided weighting to all the EVMS sub-processes and attributes that make them up (see Table 3). The outlier responses that were provided from the two workshop participants (MWSP2-4, MWSP4-11) were removed from their respective datasets as applicable (sample where that the participants had inputs in). For example, participant MWSP4-11 had provided weights on the maturity attributes that make-up the sub-process A, however MWSP2-4 did not (the participant had skipped the request of providing maturity weights on this sub-process). Therefore, the sample size is reduced from 37 to 36 in this case. Overall, the number of participants *N* that weighted the EVMS sub-processes and the different maturity attributes that make up each sub-process, after the removal of the two outliers as applicable, is shown in Table 6. Therefore, the authors assessed the data sets for these sample sizes from this point onwards (when evaluating the EVMS maturity attribute weighting data (lower-level) in Step 2).

Table 6 Number of Responses (N) Received on Weighting the EVMS Sub-processes and Attributes – After Removal of 2 Outliers

	Sub-process Weights	Attribute Weights									
		A	B	C	D	E	F	G	H	I	J
N =	46	36	35	34	33	48	47	44	44	45	44

Step 2 Evaluate the maturity attribute weighting (lower-level)

As previously discussed, participants were asked to weight the maturity attributes that make up each sub-process based on the relative impact of each to the EVMS maturity within a specific sub-process. In this step, the authors performed a lower-level detailed assessment, evaluating the weights received on attributes within sub-processes.

After the removal of the two workshop participants from the total data set as elaborated in Step 1, the authors proceeded to evaluate the maturity attribute weighting in Step 2. For that purpose and following the same approach of using boxplot analysis that was applied in Step 1, the authors generated boxplots in SPSS to analyze the weights of each maturity attribute within a given sub-process. The results of the boxplots for all the attributes are shown in Figures 11 to 20. The attributes on the boxplots are rearranged based on lowest to highest medians (left to right). The sample descriptive statistics of the workshop maturity attribute weighting data for sub-process A are given in Appendix H.
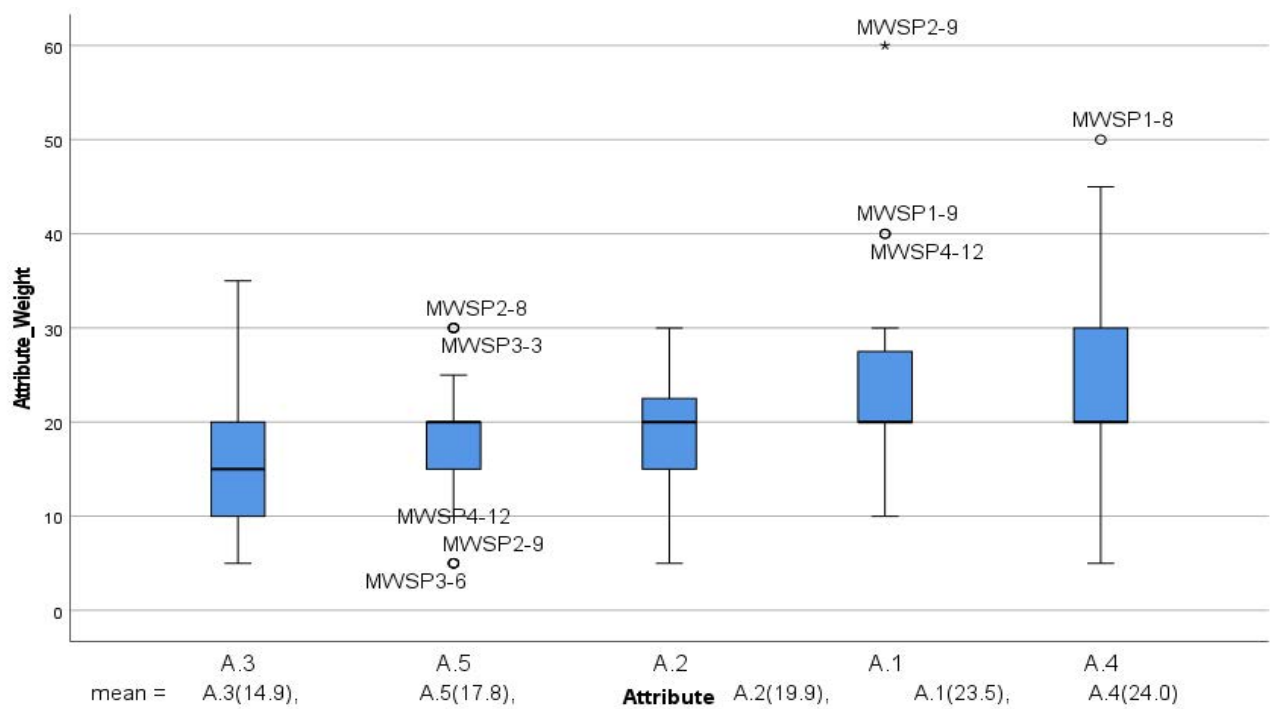
Figure 11 Attribute Weight Boxplot – Sub-process A – N=36
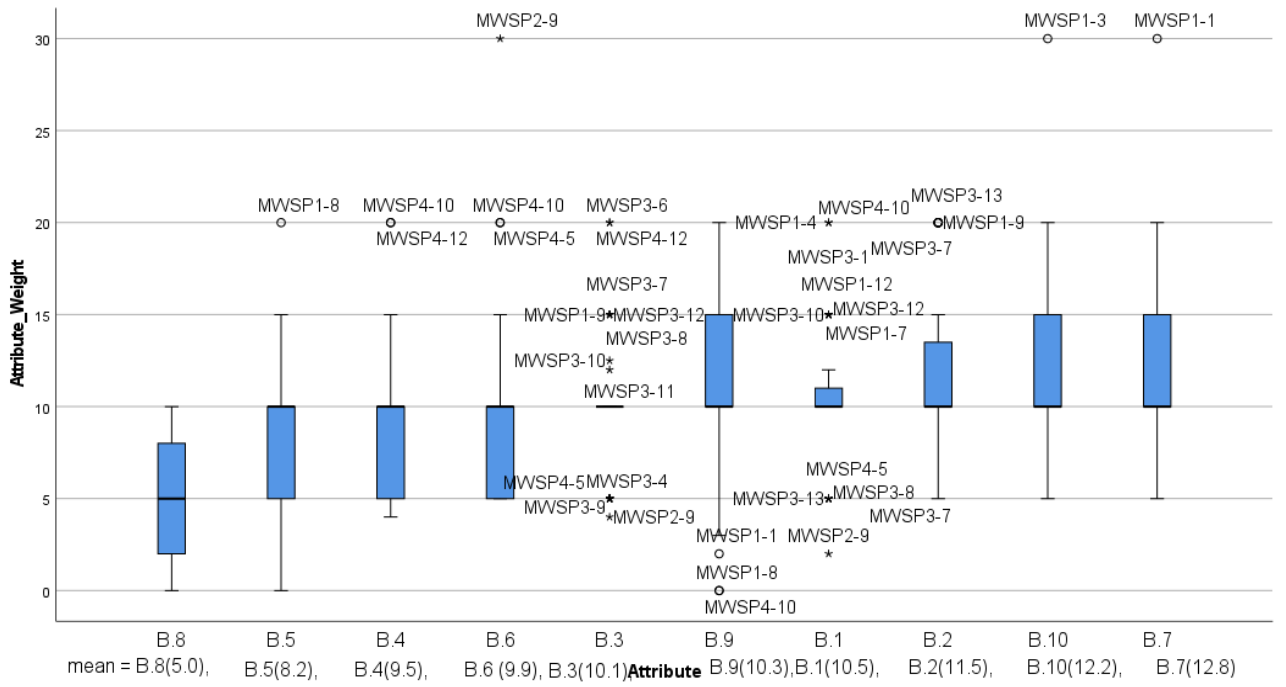
Figure 12 Attribute Weight Boxplot – Sub-process B – N=35
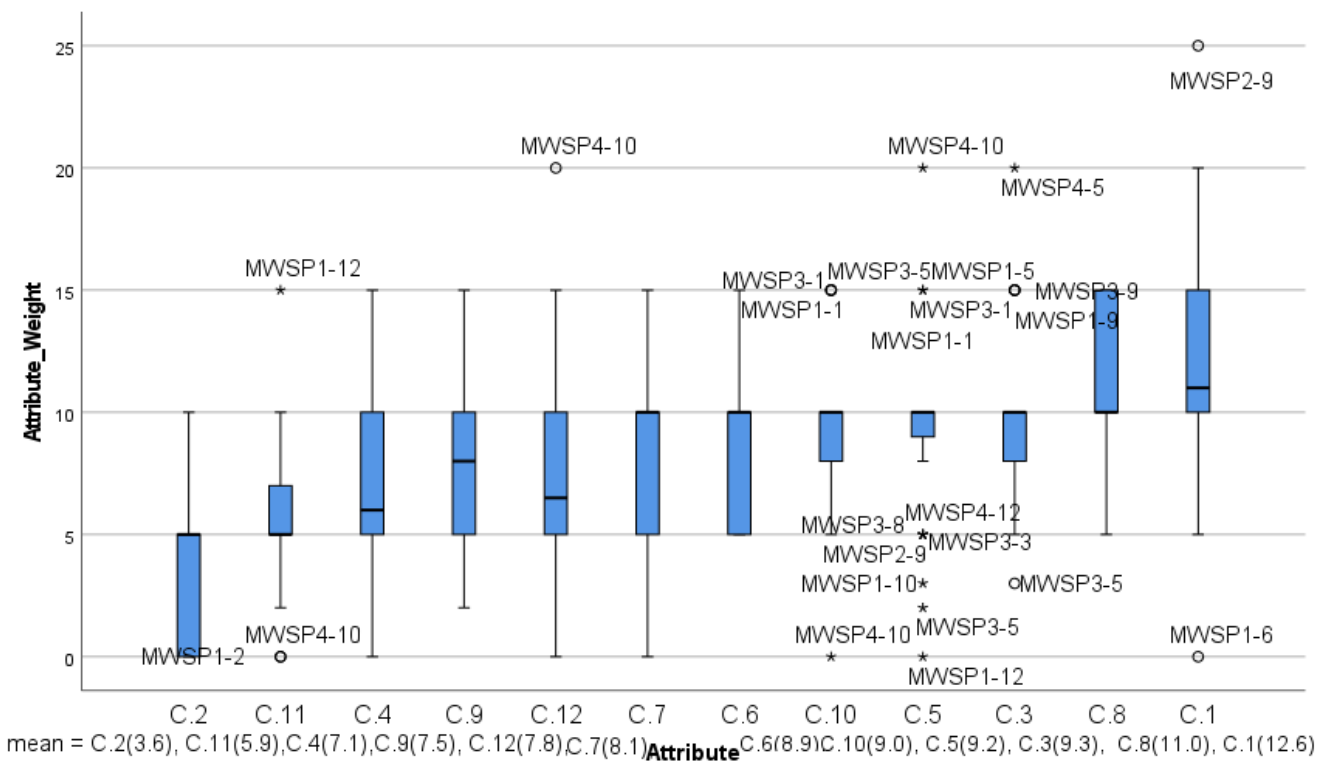
Figure 13 Attribute Weight Boxplot – Sub-process C – N=34
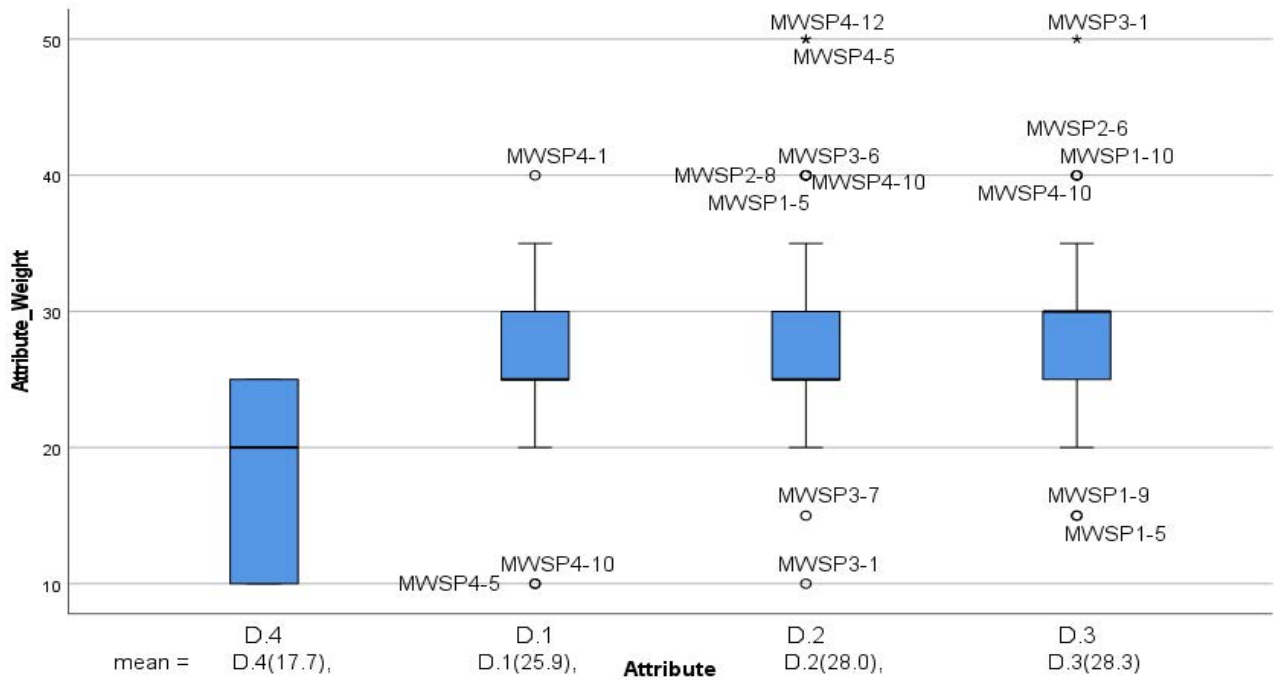
Figure 14 Attribute Weight Boxplot – Sub-process D – N=33
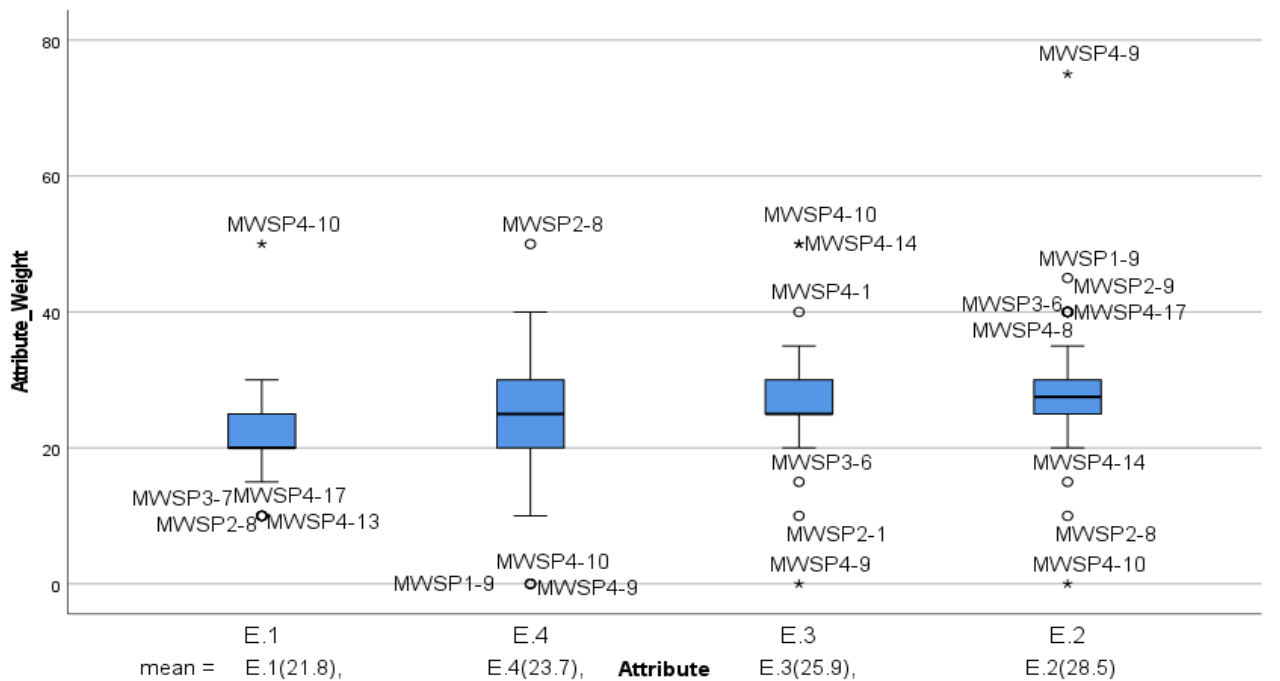
Figure 15 Attribute Weight Boxplot – Sub-process E – N=48
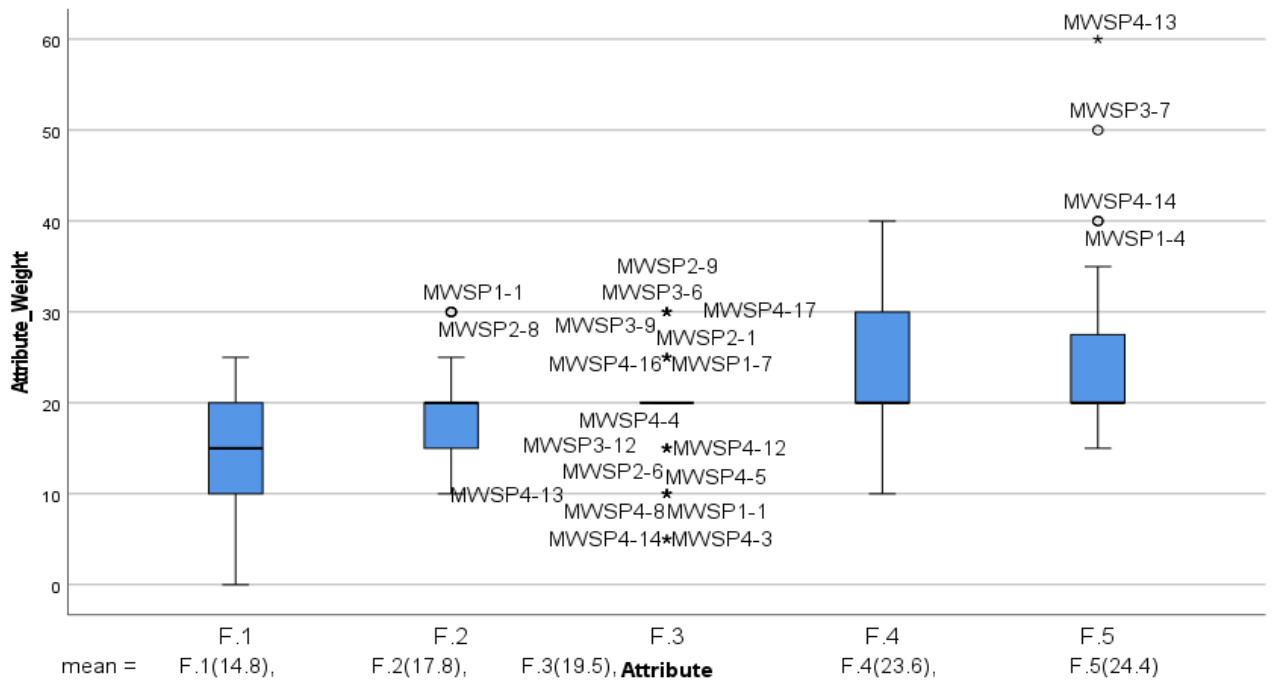
Figure 16 Attribute Weight Boxplot – Sub-process F – N=47
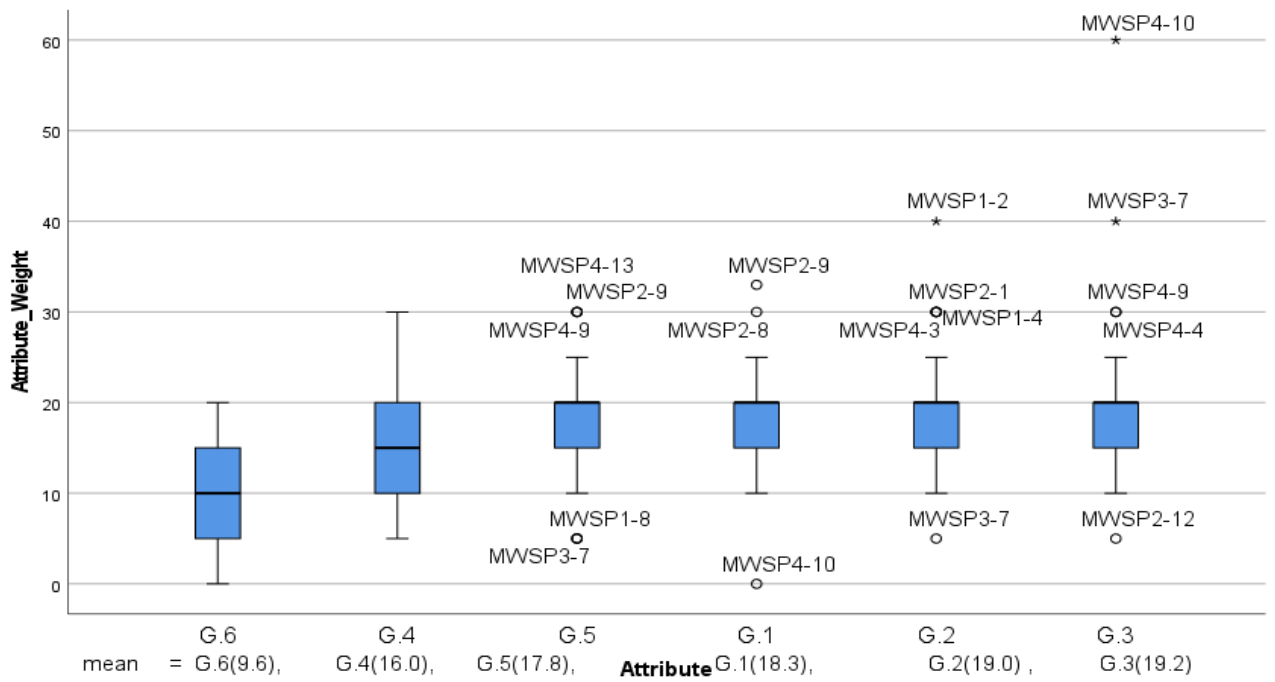
Figure 17 Attribute Weight Boxplot – Sub-process G – N=44
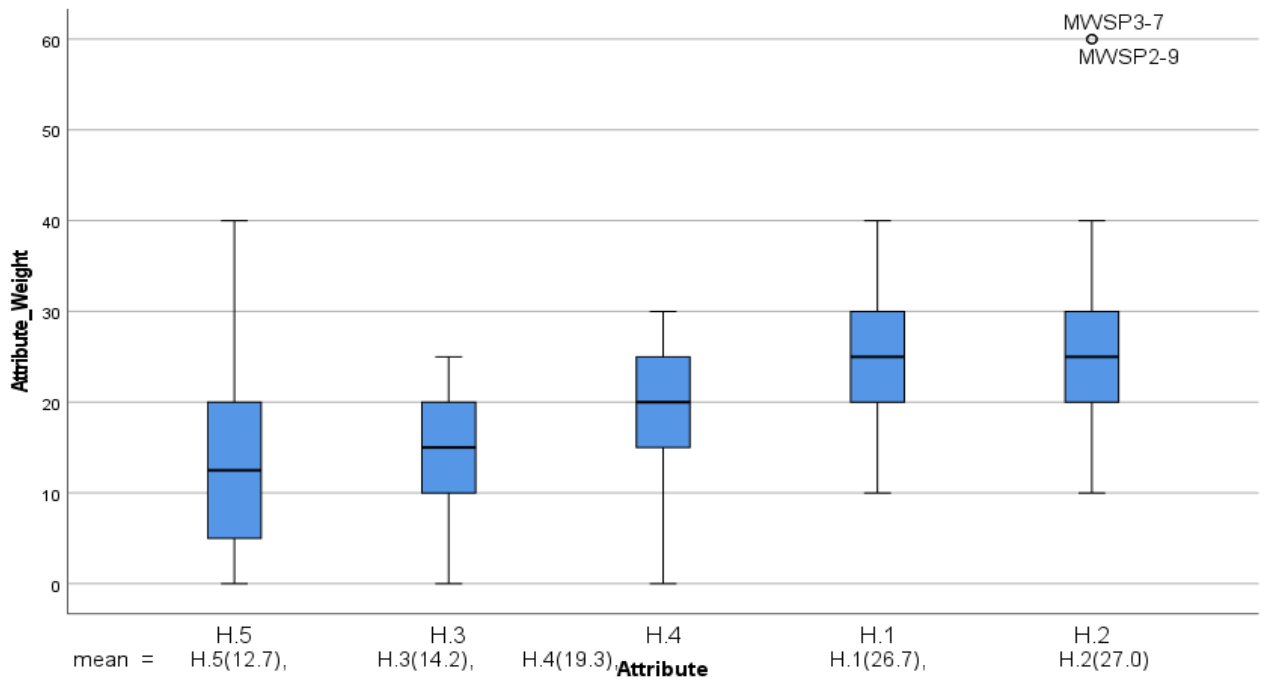
Figure 18 Attribute Weight Boxplot – Sub-process H – N=44
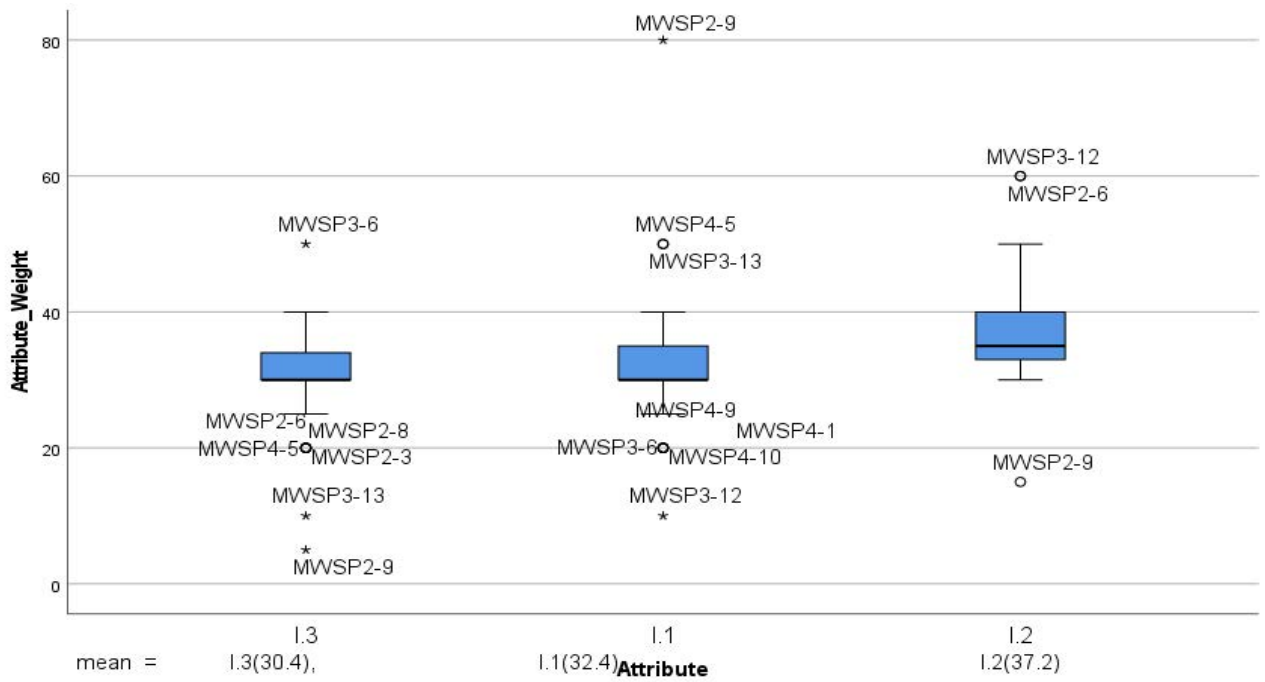
Figure 19 Attribute Weight Boxplot – Sub-process I – N=45
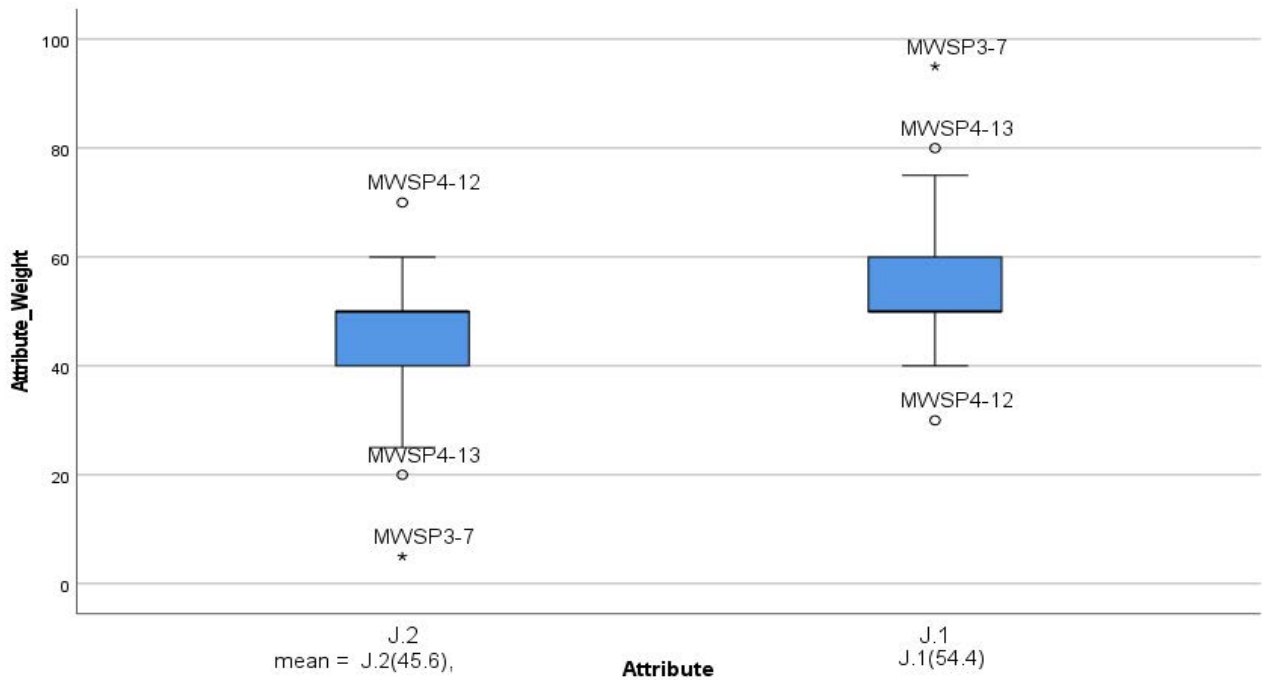
Figure 20 Attribute Weight Boxplot – Sub-process J – N=44

Based on the results shown in Figures 11 to 20, seventy-five extremes in the attribute weights provided by the participants were identified in total by thirty-four participants, and hundred and five outliers were identified also by thirty-four participants. As a result, the list of the participants and their number of outliers and extremes are shown in Tables 7 and 8.

Table 7 Attribute Outliers and Extremes based on Boxplots – A.1 to D.3

Sub-process	Attribute	Participant	# of attribute outliers:	# of attribute extremes:
A	A.1	MWSP1-9	1	
		MWSP4-12	1	
		MWSP2-9		1
	A.4	MWSP1-8	1	
	A.5	MWSP2-8	1	
		MWSP2-9	1	
		MWSP3-3	1	
		MWSP3-6	1	
		MWSP4-12	1	
B	B.1	MWSP1-4		1
		MWSP1-7		1
		MWSP1-12		1
		MWSP2-9		1
		MWSP3-1		1
		MWSP3-7		1
		MWSP3-8		1
		MWSP3-10		1
		MWSP3-12		1
		MWSP3-13		1
		MWSP4-5		1
	B.2	MWSP1-9	1	
		MWSP3-7	1	
		MWSP3-13	1	
		MWSP4-10	1	
	B.3	MWSP1-9		1
		MWSP2-9		1
		MWSP3-1		1
		MWSP3-4		1
		MWSP3-6		1
		MWSP3-7		1
		MWSP3-8		1
		MWSP3-9		1
		MWSP3-10		1
		MWSP3-11		1
		MWSP3-12		1
		MWSP4-5		1
		MWSP4-12		1
	B.4	MWSP4-10	1	
		MWSP4-12	1	
	B.5	MWSP1-8	1	
	B.6	MWSP4-5	1	
		MWSP4-10	1	
		MWSP2-9		1
	B.7	MWSP1-1	1	
	B.9	MWSP1-1	1	

Sub-process	Attribute	Participant	# of attribute outliers:	# of attribute extremes:
B	B.9	MWSP1-8	1	
		MWSP4-10	1	
	B.10	MWSP1-3	1	
C	C.1	MWSP1-6	1	
		MWSP2-9	1	
	C.3	MWSP1-9	1	
		MWSP3-1	1	
		MWSP3-5	1	
		MWSP3-9	1	
		MWSP4-5		1
	C.5	MWSP1-1		1
		MWSP1-5		1
		MWSP1-10		1
		MWSP1-12		1
		MWSP2-9		1
		MWSP3-3		1
		MWSP3-5		1
		MWSP3-8		1
		MWSP4-10		1
		MWSP4-12		1
	C.10	MWSP1-1	1	
		MWSP3-1	1	
		MWSP3-5	1	
		MWSP4-10		1
	C.11	MWSP1-2	1	
		MWSP4-10	1	
		MWSP1-12		1
	C.12	MWSP4-10	1	
D	D.1	MWSP4-1	1	
		MWSP4-5	1	
		MWSP4-10	1	
	D.2	MWSP1-5	1	
		MWSP2-8	1	
		MWSP3-1	1	
		MWSP3-6	1	
		MWSP3-7	1	
		MWSP4-10	1	
		MWSP4-5		1
		MWSP4-12		1
	D.3	MWSP1-5	1	
		MWSP1-9	1	
		MWSP1-10	1	
		MWSP2-6	1	
		MWSP4-10	1	
		MWSP3-1		1
		Total 1	48	42

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Table 8 Attribute Outliers and Extremes based on Boxplots – E.1 to J.2

Sub-process	Attribute	Participant	# of attribute outliers:	# of attribute extremes:	Sub-process	Attribute	Participant	# of attribute outliers:	# of attribute extremes:
E	E.1	MWSP2-8	1		F	F.5	MWSP4-13		1
		MWSP3-7	1		G	G.1	MWSP2-8	1	
		MWSP4-13	1				MWSP2-9	1	
		MWSP4-17	1				MWSP4-10	1	
		MWSP4-10		1		G.2	MWSP1-4	1	
	E.2	MWSP1-9	1				MWSP2-1	1	
		MWSP2-8	1				MWSP3-7	1	
		MWSP2-9	1				MWSP4-3	1	
		MWSP3-6	1				MWSP1-2		1
		MWSP4-8	1			G.3	MWSP2-12	1	
		MWSP4-14	1				MWSP4-4	1	
		MWSP4-17	1				MWSP4-9	1	
		MWSP4-9		1			MWSP3-7		1
		MWSP4-10		1			MWSP4-10		1
	E.3	MWSP2-1	1			G.5	MWSP1-8	1	
		MWSP3-6	1				MWSP2-9	1	
		MWSP4-1	1				MWSP3-7	1	
		MWSP4-9		1			MWSP4-9	1	
		MWSP4-10		1			MWSP4-13	1	
		MWSP4-14		1	H	H.2	MWSP2-9	1	
	E.4	MWSP1-9	1				MWSP3-7	1	
		MWSP2-8	1		I	I.1	MWSP3-6	1	
		MWSP4-9	1				MWSP3-13	1	
		MWSP4-10	1				MWSP4-1	1	
F	F.2	MWSP1-1	1				MWSP4-5	1	
		MWSP2-8	1				MWSP4-9	1	
	F.3	MWSP1-1		1			MWSP4-10	1	
		MWSP1-7		1			MWSP2-9		1
		MWSP2-1		1			MWSP3-12		1
		MWSP2-6		1		I.2	MWSP2-6	1	
		MWSP2-9		1			MWSP2-9	1	
		MWSP3-9		1			MWSP3-12	1	
		MWSP3-12		1		I.3	MWSP2-3	1	
		MWSP4-3		1			MWSP2-6	1	
		MWSP4-4		1			MWSP2-8	1	
		MWSP4-5		1			MWSP4-5	1	
		MWSP4-8		1			MWSP2-9		1
		MWSP4-12		1			MWSP3-6		1
		MWSP4-13		1			MWSP3-13		1
		MWSP4-14		1	J	J.1	MWSP4-12	1	
		MWSP4-16		1			MWSP4-13	1	
		MWSP4-17		1			MWSP3-7		1
	F.5	MWSP1-4	1			J.2	MWSP4-12	1	
		MWSP3-7	1				MWSP4-13	1	
		MWSP4-14	1				MWSP3-7		1
							Total 2	57	33

Overall, the 105 attribute outliers represent 4.7% of the total number of responses (2,204), whereas the 75 extremes represent 3.4%. In both cases, the outliers and the extremes identified represent less than 5% of the total number of responses.

In addition to identifying the outliers and extremes based on boxplots, and to have a closer look at the data, the authors utilized Microsoft Excel and SPSS to calculate the standard deviation of the weights in each attribute. Then each participant-given weight was expressed as a function of the calculated standard deviation. As such, the authors could highlight the participant-given attribute weights that are 2.5SD distant from the attribute mean. Figure 21 gives an example of calculating the attribute weights as a function of SD.

Attribute A.1's weight given by the workshop participant WSP2-19 is 60.00 (out of 100).

Whereas the attribute mean and standard deviation are 23.47 and 9.54, respectively.

The distance of the provided weight is 36.53 from the mean (60.00-23.47).

This distance is expressed as a function of the standard deviation as 3.83SD (36.53/9.54).

Figure 21 Example Attribute Weight as a Function of SD

This step was applied for all the participants and all the maturity attribute weights. See the sample detailed results of this step applied for all the attributes that make up sub-process A in Appendix I. The red highlighted in the appendix indicates that the attribute weight is 2.5SD distant from the attribute mean, for those attributes which were weighted by participants. In total, forty-eight weights have been identified as 2.5SD distant from attribute weight mean, by twenty-two participants.

Next, the authors used equation (2) to calculate the attribute "contribution scores" for all participants based on the number of outliers, extremes and whether their attribute weight was 2.5SD distant from the mean for each sub-process.

Table 9 shows each workshop participant's attribute contribution score for the total of 54 participants (after the removal of two outlier responses from two workshop participants, out of the total 56 participants). The responses with high contribution scores of 6 to 10 are highlighted in yellow, whereas those higher than 10 are highlighted in light red. Figure 22 provides the contribution scores (by score category) in a bar chart format. Viewing the weighting data in this fashion highlighted the contribution score ranges skewing the mean attribute weights the most, and ranges of scores that were relatively higher than the total workshop participant set.

Table 9 Workshop Participant Attribute Contribution Scores – N=54

Workshop Participant	# of Outliers	# of Extremes	x	Contribution Score	Workshop Participant	# of Outliers	# of Extremes	x	Contribution Score
MWSP1-1	4	2	2	8	MWSP3-4	0	1	0	1
MWSP1-2	1	1	1	3	MWSP3-5	2	1	0	3
MWSP1-3	1	0	1	2	MWSP3-6	5	2	1	8
MWSP1-4	2	1	0	3	MWSP3-7	7	5	2	14
MWSP1-5	2	1	0	3	MWSP3-8	0	3	0	3
MWSP1-6	1	0	1	2	MWSP3-9	1	2	0	3
MWSP1-7	0	2	1	3	MWSP3-10	0	2	0	2
MWSP1-8	4	0	2	6	MWSP3-11	0	1	0	1
MWSP1-9	6	1	0	7	MWSP3-12	1	4	1	6
MWSP1-10	1	1	0	2	MWSP3-13	2	2	1	5
MWSP1-11	0	0	0	0	MWSP4-1	3	0	0	3
MWSP1-12	0	3	1	4	MWSP4-2	0	0	0	0
MWSP2-1	2	1	0	3	MWSP4-3	1	1	1	3
MWSP2-2	0	0	0	0	MWSP4-4	1	1	0	2
MWSP2-3	1	0	0	1	MWSP4-5	4	5	1	10
MWSP2-5	0	0	0	0	MWSP4-6	0	0	0	0
MWSP2-6	3	1	1	5	MWSP4-7	0	0	0	0
MWSP2-7	0	0	0	0	MWSP4-8	1	1	0	2
MWSP2-8	8	0	1	9	MWSP4-9	4	2	2	8
MWSP2-9	7	8	2	17	MWSP4-10	12	6	2	20
MWSP2-10	0	0	0	0	MWSP4-12	5	4	1	10
MWSP2-11	0	0	0	0	MWSP4-13	4	2	1	7
MWSP2-12	1	0	0	1	MWSP4-14	2	2	2	6
MWSP2-13	0	0	0	0	MWSP4-15	0	0	0	0
MWSP3-1	3	3	1	7	MWSP4-16	0	1	0	1
MWSP3-2	0	0	0	0	MWSP4-17	2	1	0	3
MWSP3-3	1	1	0	2	MWSP4-18	0	0	0	0

Note: The responses with contribution scores of 6 to 10 are highlighted in yellow, those higher than 10 are highlighted in light red.
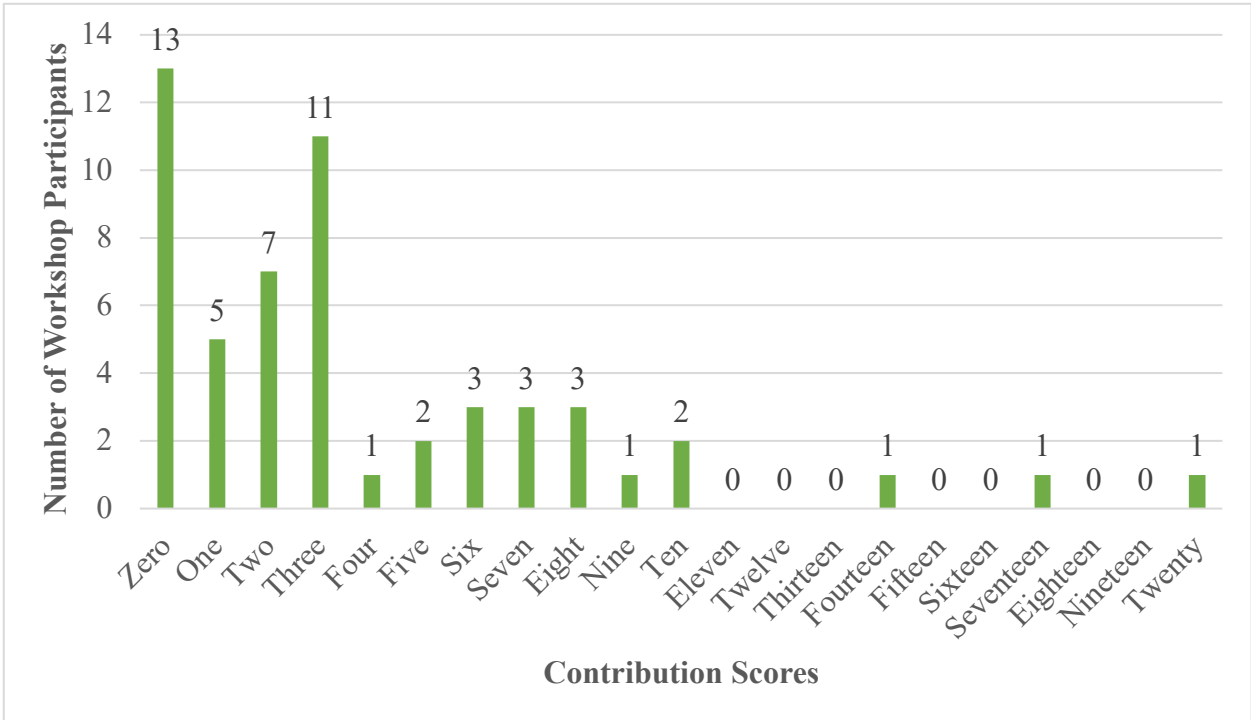
Figure 22 Workshop Participant Contribution Scores (By Score Category) – N =54

The team decided that the workshop participants with a contribution score greater than ten should be removed from the data set. This was a logical conclusion based on looking closer to the combination of distance from mean and having outliers and extremes on boxplot. Therefore, the data set from three workshop participants (MWSP2-9, MWSP3-7, and MWSP4-10) was removed from the total data set.

In summary, MWSP2-9, MWSP3-7, and MWSP4-10 were added to the list of the two participants (MWSP2-4 and MWSP4-11) which were previously removed based on a higher-level sub-process analysis. In total, the removal of five participant data leads to responses coming from 51 workshop participants that are useful to the derivation of maturity weights in IP2M METRR. For instance, the question that requested weights on the ten sub-processes based on relative importance originally received 48 responses. After the first outlier analysis (higher-level outlier analysis), two responses were removed therefore this sample size was reduced to N=46. Based on the following outlier analysis (lower-level), three additional outliers were removed, therefore the sample size is further reduced to N=43. As such, the number of participants *N* that weighted the EVMS sub-processes and the different maturity attributes that make up each sub-process, after the removal of the five outliers as applicable, is shown in Table 10 (as explained earlier, not all the workshop participants provided weighting to all the EVMS sub-processes and attributes that make them up).

Table 10 Number of Responses (N) Received on Weighting the EVMS sub-processes and Attributes – After Removal of 5 outliers

	Sub-process Weights	Attribute Weights									
		A	B	C	D	E	F	G	H	I	J
N =	43	33	32	31	30	45	44	41	41	42	41

Furthermore, the workshop weighting results after the removal of the five outliers for maturity attributes under the sub-process A is shown in Figure 23. The sample results for the maturity attributes and EVMS sub-processes are shown in Appendix J. See next section for an example and details.
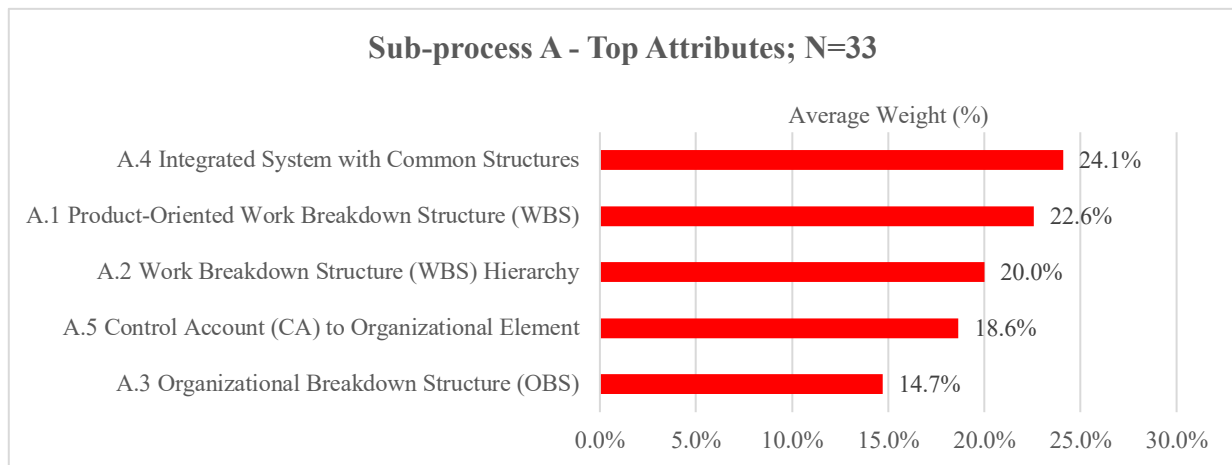

Sub-process A - Top Attributes; N=33

Average Weight (%)

Attribute	Value
A.4 Integrated System with Common Structures	24.1%
A.1 Product-Oriented Work Breakdown Structure (WBS)	22.6%
A.2 Work Breakdown Structure (WBS) Hierarchy	20.0%
A.5 Control Account (CA) to Organizational Element	18.6%
A.3 Organizational Breakdown Structure (OBS)	14.7%

Figure 23 Sub-process A Attributes Average Weight Results After Removal of All Outliers – N=33

The next section describes the procedures used for finalizing the IP2M METRR Maturity score sheets.

5.2. Finalizing the EVMS Maturity Score Sheets

Appendix J shows the participant demographics, and sample data results for the total of 51 datasets (excluding the five outlier participant data), by applying equation (1) on the 51 datasets to calculate the average weight per attribute, as well as calculating the average of the weights given by the participants for each EVMS sub-process. The results were rounded to the nearest tenth; for this, numbers with decimals equal or greater than .05 were rounded up, and numbers with decimals less than .05 were rounded down. Figure 24 gives an example for calculating the maturity attribute relative weight, after outliers were removed.

Attribute A.1 (Product-Oriented Work Breakdown Structure) received a total weight of 745 by 33 participants.

Applying equation (1) results into the attribute's average weight, which is 22.6 (745/33).

Figure 24 Example Maturity Attribute Relative Weight

This was done for all the 56 maturity attributes and ten EVMS sub-processes. See Appendix J for the sample data results. This information will be used in the further steps described below.

Before generating the final score sheets, it was necessary to decide a scoring range for EVMS maturity. As such, the authors and the research team held a meeting on December 8, 2020, to make a final decision on the scoring range for both EVMS environment, and maturity assessment. After going through discussions, the research team decided to consider a score range of 0-1000 as this range contains more precision/differentiation in scores when assessing the EVMS maturity (also mentioned in Research Report 3 Annex).

Several Schemes were attempted to make sure that maturity weights were established in the best manner possible as given below.

First, in order to normalize the average weights of all the 56 attributes across all the sub-processes, and by considering a scoring range of 0-1000, the following equation was applied in Scheme A.

Equation (3): Normalized Weighted Score per attribute across all EVMS sub-processes:

Scheme A:

$$Normalized\ Weighted\ Score\ = \overline{x_n}\ \% \times Sub\_process\ Average\ \% \times 1000$$

Normalized Weighted Score: Attribute weight relative to all other maturity attributes (in %)

$\overline{x_n}$: Average attribute weight within a specific sub-process, result of equation (1) (in %)

Sub-process Average: Average of the weights given by participants for each EVMS sub-process

In summary, the normalized weighted score for each of the 56 attributes was calculated by multiplying sub-process percentages by attribute percentages $\times$ *1000.* All the calculated normalized weighted scores sum up to 1000.

Figure 25 gives an example of equation (3) application: calculating the normalized weighted score for each attribute in Scheme A.

Attribute A.1 is "Product-Oriented Work Breakdown Structure (WBS)"; applying the equation (1) resulted into the attribute's average weight ($\overline{x_n}$), which is 22.6% within sub-process A (Organizing).

Whereas the sub-process A's average weight given by the participants is 10.5%.

Applying the Scheme A's equation (3) results into the attribute's normalized weighted score, which is 23.73 percent ($0.226 \times 0.105 \times 1000$), rounded to 24.

Figure 25 Example Attribute Score – Scheme A

This step was done for all the 56 attributes and the results of the normalized attributed weighted scores are shown in Appendix K.

Then, in order to determine the scores for the different maturity levels in each attribute (Not Applicable, 1, 2, 3, 4, 5), calculations of scores by linear interpolation between the levels "1" and "5" was performed. Here, rounding of each number was necessary to complete the maturity score sheet, as only integers are used as weights on the maturity score sheets. A standard rounding procedure was used, where numbers with decimals equal to or greater than .50 were rounded up, and numbers with decimals less than .50 were rounded down. The authors followed the following steps to generate the scores of the maturity score sheets, with an example shown next.

For each attribute, the following was applied:

$$\text{Level "Not Applicable"} = \text{No Score}$$
$$\text{Level "1"} = 0$$
$$\text{Level "2"} = \text{Level "1"} + \text{Normalized Weighted Score} / 4$$
$$\text{Level "3"} = \text{Level "2"} + \text{Normalized Weighted Score} / 4$$
$$\text{Level "4"} = \text{Level "3"} + \text{Normalized Weighted Score} / 4$$
$$\text{Level "5"} = \text{Normalized Weighted Score}$$

The authors' assumption is that attributes have a linear progression in terms of importance. Figure 26 gives an example of score calculation at the different maturity levels in Scheme A.

In Scheme A, recall that the attribute A.1's level 5 score was 23.73.

- Not Applicable = No score
- Level "1" = 0
- Level "2" = 0 + 23.73 / 4 = 5.93, rounded to 6
- Level "3" = 5.93 + 5.93 = 11.86, rounded to 12
- Level "4" = 11.86 + 5.93 = 17.79, rounded to 18
- Level "5" = 23.73, rounded to 24

Figure 26 Example Attribute Score Calculation for all Maturity Levels – Scheme A

Therefore Table 11 shows the score sheet result for A.1 in Scheme A.

Table 11 Example of score sheet result for A.1 – Scheme A

Attribute	N/A	Maturity Level				
		1	2	3	4	5
A.1. Product-Oriented Work Breakdown Structure (WBS)		0	6	12	18	24

The following tables represent the results of scores of the different maturity levels for all the maturity attributes by following the above steps for Scheme A.

Scheme A Score Sheets

Table 12 Sub-process A Score Sheet

SUB-PROCESS A – ORGANIZING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
A.1. **Product-Oriented Work Breakdown Structure (WBS)**		0	6	12	18	24	
A.2. **Work Breakdown Structure (WBS) Hierarchy**		0	5	11	16	21	
A.3. **Organizational Breakdown Structure (OBS)**		0	4	8	12	15	
A.4. **Integrated System with Common Structures**		0	6	13	19	25	
A.5. **Control Account (CA) to Organizational Element**		0	5	10	15	20	
Sub-process A – Organizing, Column Frequency Totals		**0**	**26**	**54**	**80**	**105**	

Table 13 Sub-process B Score Sheet

SUB-PROCESS B – PLANNING AND SCHEDULING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
B.1. **Authorized, Time-Phased Work Scope**		0	4	9	13	17	
B.2. **Schedule Provides Current Status**		0	4	9	13	17	
B.3. **Horizontal Integration**		0	4	8	12	16	
B.4. **Vertical Integration**		0	4	7	11	15	
B.5. **Integrated Master Schedule (IMS) Resources**		0	3	7	10	13	
B.6. **Schedule Detail**		0	4	7	11	14	
B.7. **Critical Path and Float**		0	5	10	16	21	
B.8. **Schedule Margin (SM)**		0	2	4	6	8	
B.9. **Progress Measures and Indicators**		0	4	8	12	16	
B.10. **Time-Phased Performance Measurement Baseline (PMB)**		0	5	10	15	20	
Sub-process B – Planning and Scheduling, Column Frequency Totals		**0**	**39**	**79**	**119**	**157**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

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Table 14 Sub-process C Score Sheet

SUB-PROCESS C – BUDGETING AND WORK AUTHORIZATION							
Attribute	N/A	1	2	3	4	5	Comments
C.1. Scope, Schedule and Budget Alignment		0	4	7	11	15	
C.2. Summary Level Planning Packages (SLPPs)		0	1	2	3	4	
C.3. Work Authorization Documents (WADs)		0	3	6	9	12	
C.4. Work Authorization Prior to Performance		0	2	4	6	9	
C.5. Budgeting by Elements of Cost (EOC)		0	3	5	8	11	
C.6. Work Package Planning, Distinguishability, and Duration		0	3	5	8	11	
C.7. Measurable Units and Budget Substantiation		0	3	5	8	10	
C.8. Appropriate Assignment of Earned Value Techniques (EVTs)		0	3	7	10	13	
C.9. Identify and Control Level of Effort (LOE) Work Scope		0	2	5	7	9	
C.10. Identify Management Reserve (MR) Budget		0	3	6	9	11	
C.11. Undistributed Budget (UB)		0	2	4	6	8	
C.12. Reconcile to Target Cost Goal		0	2	5	7	9	
Sub-process C – Budgeting and Work Authorization, Column Frequency Totals		**0**	**31**	**61**	**92**	**122**	

Table 15 Sub-process D Score Sheet

SUB-PROCESS D – ACCOUNTING CONSIDERATIONS							
Attribute	N/A	1	2	3	4	5	Comments
D.1. Direct Costs		0	5	10	16	21	
D.2. Actual Cost Reconciliation		0	6	11	17	22	
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)		0	5	11	16	22	
D.4. Direct Cost Breakdown Summary		0	4	7	11	14	
Sub-process D – Accounting Considerations, Column Frequency Totals		**0**	**20**	**39**	**60**	**79**	

Maturity Levels

N/A= Not Applicable	2 = Major Gaps	4 = No Gaps
1 = Not Yet Started	3 = Minor Gaps	5 = Best in Class

Table 16 Sub-process E Score Sheet

SUB-PROCESS E – INDIRECT BUDGET AND COST MANAGEMENT							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
E.1. Indirect Account Organization Structure		0	3	7	10	14	
E.2. Indirect Budget Management		0	5	9	14	19	
E.3. Record/Allocate Indirect Costs		0	4	8	12	16	
E.4. Indirect Variance Analysis		0	4	8	12	16	
Sub-process E – Indirect Budget and Cost Management, Column Frequency Totals		**0**	**16**	**32**	**48**	**65**	

Table 17 Sub-process F Score Sheet

SUB-PROCESS F – ANALYSIS AND MANAGEMENT REPORTING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
F.1. Calculating Variances		0	5	9	14	18	
F.2. Variances to Control Accounts (CAs)		0	5	11	16	21	
F.3. Performance Measurement Information		0	6	12	17	23	
F.4. Management Analysis and Corrective Actions		0	7	14	22	29	
F.5. Estimates at Completion (EAC)		0	7	14	21	29	
Sub-process F – Analysis and Management Reporting, Column Frequency Totals		**0**	**30**	**60**	**90**	**120**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 18 Sub-process G Score Sheet

SUB-PROCESS G – CHANGE CONTROL							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
G.1. **Controlling Management Reserve (MR) and Undistributed Budget (UB)**		0	5	11	16	21	
G.2. **Incorporate Customer Directed Changes in a Timely Manner**		0	6	12	17	23	
G.3. **Baseline Changes Reconciliation**		0	5	10	15	21	
G.4. **Control of Retroactive Changes**		0	5	9	14	19	
G.5. **Preventing Unauthorized Revisions to the Contract Budget Base (CBB)**		0	5	11	16	21	
G.6. **Over-Target Baseline (OTB) Authorization**		0	3	6	9	12	
Sub-process G – Change Control, Column Frequency Totals		**0**	**29**	**59**	**87**	**117**	

Table 19 Sub-process H Score Sheet

SUB-PROCESS H – MATERIAL MANAGEMENT							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
H.1. **Recording Actual Material Costs**		0	4	9	13	17	
H.2. **Material Performance**		0	4	8	13	17	
H.3. **Residual Material**		0	3	5	8	10	
H.4. **Material Price/Usage Variance**		0	3	7	10	13	
H.5. **Identification of Unit Costs and Lot Costs**		0	2	4	6	9	
Sub-process H – Material Management, Column Frequency Totals		**0**	**16**	**33**	**50**	**66**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 20 Sub-process I Score Sheet

SUB-PROCESS I – SUBCONTRACT MANAGEMENT							
Attribute	**N/A**	**Maturity Level**					**Comments**
		1	**2**	**3**	**4**	**5**	
I.1. **Subcontract Identification and Requirements Flow Down**		0	6	13	19	25	
I.2. **Subcontractor Integration and Analysis**		0	7	15	22	30	
I.3. **Subcontract Oversight**		0	6	12	19	25	
Sub-process I – Subcontract Management, Column Frequency Totals		**0**	**19**	**40**	**60**	**80**	

Table 21 Sub-process J Score Sheet

SUB-PROCESS J – RISK MANAGEMENT							
Attribute	**N/A**	**Maturity Level**					**Comments**
		1	**2**	**3**	**4**	**5**	
J.1. **Identify, Analyze and Manage Risk**		0	12	24	36	48	
J.2. **Risk Integration**		0	10	21	31	41	
Sub-process J – Risk Management, Column Frequency Totals		**0**	**22**	**45**	**67**	**89**	

Maturity Levels

N/A= Not Applicable   2 = Major Gaps   4 = No Gaps
1 = Not Yet Started   3 = Minor Gaps   5 = Best in Class

For better visualization of the score portions of each attribute relative to one another across the total 1000 points, a pie chart was formed for Scheme A, shown in Figure 27.
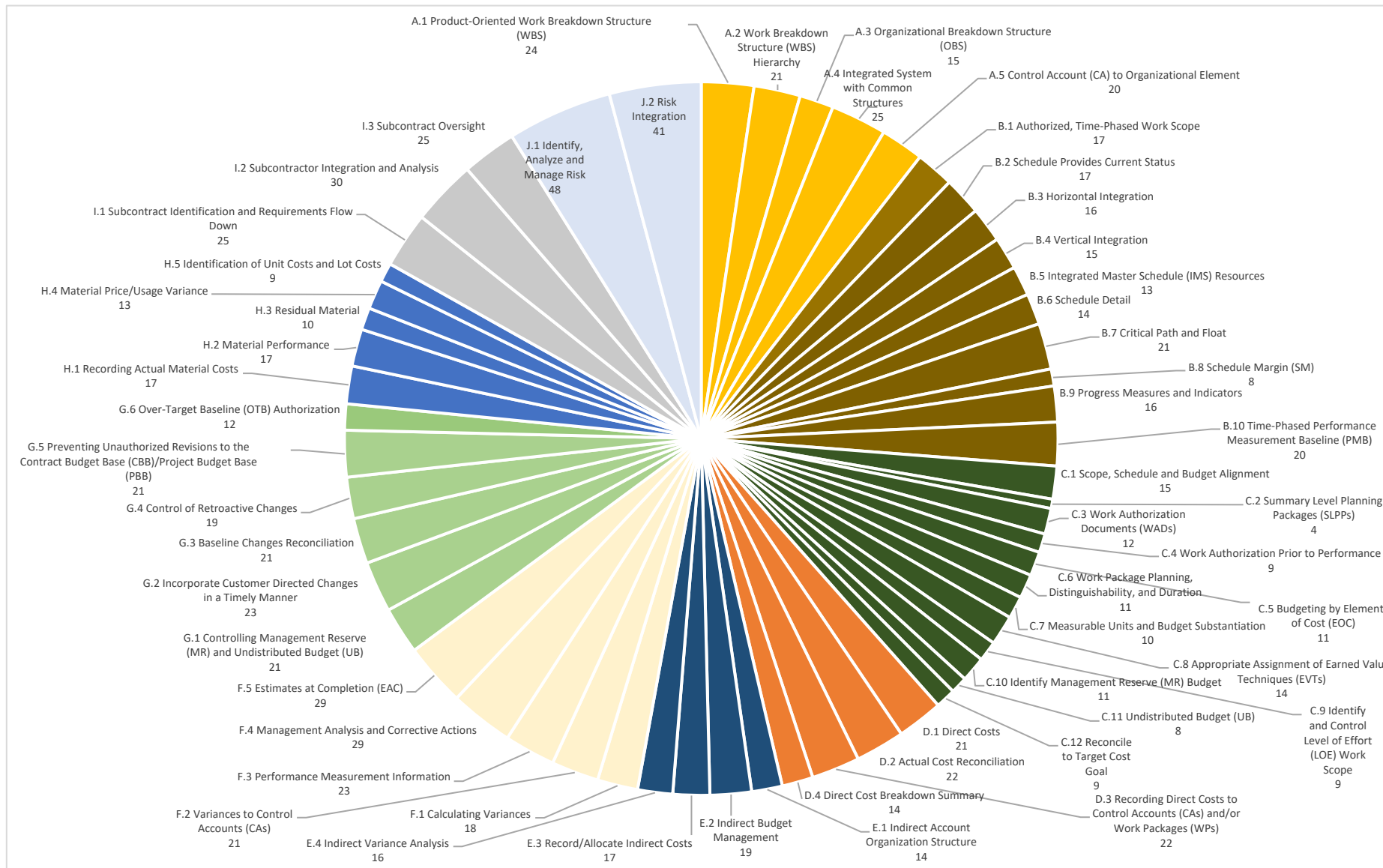

Figure 27 Scheme A Score Pie Chart

The authors identified a problem with using Scheme A; the different numbers of attributes making up each sub-process inflated/deflated the scores of some attributes. See below examples:

1. Since sub-process J (Risk Management) has only two attributes, the total score of sub-process J was divided amongst two attributes only, resulting in J.1 (Identify, Analyze and Manage Risk) and J.2 (Risk Integration) having the highest attribute scores among all attributes.
2. Since sub-process C (Budgeting and Work Authorization) had the highest number of attributes (12 attributes), the total score of sub-process C was divided amongst 12 attributes, resulting in the scores of the individual attributes being way lower than the scores of attributes J.1 and J.2. For example, C.1 (Scope, Schedule and Budget Alignment) scores 15, the maximum score in sub-process C, is three times lower than J.1's score of 48.

Scheme B:

Therefore, the frequency of the attributes within a given sub-process impacted the scores. In order to address this issue, the authors developed a new score calculation method, Scheme B, which added a new multiplier entitled "attribute distribution factor (%)" that took into account the number of attributes that make up each sub-process. This factor was calculated by dividing the number of attributes per sub-process by 56 (since the total number of attributes is 56), multiplied by 100. The details and an example are given next.

The following equation was applied in Scheme B.

Equation (4): Scheme B level 5 score:

$$Normalized\ Weighted\ Score =$$

$$= \frac{\overline{x_n} \times Sub\_process\ Percentage \ \times \ Attribute\ Distribution\ Factor}{summation\ of\ the\ numerator\ across\ all\ the\ 56\ attributes} \times 1000$$

With,

$$Attribute\ Distribution\ Factor$$
$$= \frac{Number\ of\ Attributes\ under\ each\ sub\_process}{56\ Attributes} \times 100$$

Normalized Weighted Score: Attribute weight relative to all other maturity attributes (in %)

$\overline{x_n}$: Average attribute weight within a specific sub-process, result of equation (1) (in %)

Sub-process Average: Average of the weights given by participants for each EVMS sub-process

Attribute Distribution Factor: Factor representing a given sub-process's attribute shares within the total of 56 attributes (in %)

For example, sub-process A (Organizing) has five attributes, therefore the Attribute Distribution Factor is 8.93% (result of 5 / 56 × 100). This step was repeated for all the sub-processes and the results are shown in Table 22.

Table 22 Attribute Distribution Factor – Scheme B

Sub-process	Number of attributes per sub-process	Attribute Distribution Factor
A	5	8.93%
B	10	17.86%
C	12	21.43%
D	4	7.14%
E	4	7.14%
F	5	8.93%
G	6	10.71%
H	5	8.93%
I	3	5.36%
J	2	3.57%
Total:	56	100.00%

In summary, the normalized weighted score for each of the 56 attributes was calculated by multiplying sub-process percentages by attribute percentages × *1000*, as well as the attribute distribution factor. All the calculated normalized weighted scores sum up to 1000.

Scheme B:

Figure 28 gives an example of equation (4) application: calculating the normalized weighted score for each attribute in Scheme B.

Attribute A.1 is "Product-Oriented Work Breakdown Structure (WBS)"; applying the equation (1) resulted into the attribute's average attribute weight ($\overline{x_n}$), which is 22.6% within sub-process A (Organizing).

Whereas the sub-process A's average weight given by the participants is 10.5%.

In this case, the "Attribute Distribution Factor" for sub-process A as per Table 22 is 8.93%.

The numerator of equation (4) results into 0.0021 (result of $0.226 \times 0.105 \times 8.93\%$).

The denominator is the sum of the repeating this step across all 56 attributes, producing 0.11048.

Therefore, the normalized weighted score in Scheme B for attribute A.1 is (0.0021 / 0.11048) ×1000 = 19.18, rounded to 19.

Figure 28 Example Attribute Score – Scheme B

The authors followed the same approach as in Scheme A, where the scores of the various levels are based on a linear progression on importance. Figure 29 gives an example of score calculation at the different maturity levels in Scheme B.

In Scheme B, recall that the attribute A.1's level 5 score was 19.18.

- Not Applicable = No score
- Level "1" = 0
- Level "2" = 0 + 19.18 / 4 = 4.79, rounded to 5
- Level "3" = 4.79 + 4.79 = 9.58, rounded to 10
- Level "4" = 9.58 + 4.79 = 14.37, rounded to 14
- Level "5" = 19.18, rounded to 19

Figure 29 Example Attribute Score Calculation for all Maturity Levels – Scheme B

Therefore Table 23 shows the score sheet result for A.1 in Scheme B.

Table 23 Example of score sheet result for A.1 – Scheme B

Attribute	N/A	Maturity Level				
		1	2	3	4	5
A.1. Product-Oriented Work Breakdown Structure (WBS)		0	5	10	14	19

The following tables represent the results of scores of the different maturity levels for all the maturity attributes by following the above steps for Scheme B.

Scheme B Score Sheets

Table 24 Sub-process A Score Sheet (Scheme B)

SUB-PROCESS A – ORGANIZING							
Attribute	**N/A**	**Maturity Level**					**Comments**
		1	**2**	**3**	**4**	**5**	
A.1. Product-Oriented Work Breakdown Structure (WBS)		0	5	10	14	19	
A.2. Work Breakdown Structure (WBS) Hierarchy		0	4	8	13	17	
A.3. Organizational Breakdown Structure (OBS)		0	3	6	9	13	
A.4. Integrated System with Common Structures		0	5	10	15	20	
A.5. Control Account (CA) to Organizational Element		0	4	8	12	16	
Sub-process A – Organizing, Column Frequency Totals		**0**	**21**	**42**	**63**	**85**	

Table 25 Sub-process B Score Sheet (Scheme B)

SUB-PROCESS B – PLANNING AND SCHEDULING							
Attribute	**N/A**	**Maturity Level**					**Comments**
		1	**2**	**3**	**4**	**5**	
B.1. Authorized, Time-Phased Work Scope		0	7	14	21	28	
B.2. Schedule Provides Current Status		0	7	14	21	28	
B.3. Horizontal Integration		0	6	13	19	26	
B.4. Vertical Integration		0	6	12	18	24	
B.5. Integrated Master Schedule (IMS) Resources		0	5	11	16	22	
B.6. Schedule Detail		0	6	11	17	23	
B.7. Critical Path and Float		0	8	17	25	34	
B.8. Schedule Margin (SM)		0	3	6	9	13	
B.9. Progress Measures and Indicators		0	7	13	20	26	
B.10. Time-Phased Performance Measurement Baseline (PMB)		0	8	16	24	32	
Sub-process B – Planning and Scheduling, Column Frequency Totals		**0**	**63**	**127**	**190**	**256**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 26 Sub-process C Score Sheet (Scheme B)

SUB-PROCESS C – BUDGETING AND WORK AUTHORIZATION							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
C.1. Scope, Schedule and Budget Alignment		0	7	14	22	29	
C.2. Summary Level Planning Packages (SLPPs)		0	2	4	6	8	
C.3. Work Authorization Documents (WADs)		0	6	11	17	23	
C.4. Work Authorization Prior to Performance		0	4	8	12	17	
C.5. Budgeting by Elements of Cost (EOC)		0	5	11	16	21	
C.6. Work Package Planning, Distinguishability, and Duration		0	5	11	16	21	
C.7. Measurable Units and Budget Substantiation		0	5	10	15	20	
C.8. Appropriate Assignment of Earned Value Techniques (EVTs)		0	7	13	20	26	
C.9. Identify and Control Level of Effort (LOE) Work Scope		0	4	9	13	18	
C.10. Identify Management Reserve (MR) Budget		0	6	11	17	22	
C.11. Undistributed Budget (UB)		0	4	7	11	15	
C.12. Reconcile to Target Cost Goal		0	4	9	13	18	
Sub-process C – Budgeting and Work Authorization, Column Frequency Totals		**0**	**59**	**118**	**178**	**238**	

Table 27 Sub-process D Score Sheet (Scheme B)

SUB-PROCESS D – ACCOUNTING CONSIDERATIONS							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
D.1. Direct Costs		0	3	7	10	13	
D.2. Actual Cost Reconciliation		0	4	7	11	14	
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)		0	4	7	11	14	
D.4. Direct Cost Breakdown Summary		0	2	5	7	9	
Sub-process D – Accounting Considerations, Column Frequency Totals		**0**	**13**	**26**	**39**	**50**	

Maturity Levels

N/A= Not Applicable   2 = Major Gaps   4 = No Gaps
1 = Not Yet Started   3 = Minor Gaps   5 = Best in Class

Table 28 Sub-process E Score Sheet (Scheme B)

SUB-PROCESS E – INDIRECT BUDGET AND COST MANAGEMENT							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
E.1. Indirect Account Organization Structure		0	2	4	7	9	
E.2. Indirect Budget Management		0	3	6	9	12	
E.3. Record/Allocate Indirect Costs		0	3	5	8	11	
E.4. Indirect Variance Analysis		0	3	5	8	10	
Sub-process E – Indirect Budget and Cost Management, Column Frequency Totals		**0**	**11**	**20**	**32**	**42**	

Table 29 Sub-process F Score Sheet (Scheme B)

SUB-PROCESS F – ANALYSIS AND MANAGEMENT REPORTING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
F.1. Calculating Variances		0	4	7	11	15	
F.2. Variances to Control Accounts (CAs)		0	4	9	13	17	
F.3. Performance Measurement Information		0	5	9	14	19	
F.4. Management Analysis and Corrective Actions		0	6	12	17	23	
F.5. Estimates at Completion (EAC)		0	6	12	17	23	
Sub-process F – Analysis and Management Reporting, Column Frequency Totals		**0**	**25**	**49**	**72**	**97**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 30 Sub-process G Score Sheet (Scheme B)

SUB-PROCESS G – CHANGE CONTROL							
		Maturity Level					
Attribute	N/A	1	2	3	4	5	Comments
G.1. Controlling Management Reserve (MR) and Undistributed Budget (UB)		0	5	10	16	21	
G.2. Incorporate Customer Directed Changes in a Timely Manner		0	6	11	17	22	
G.3. Baseline Changes Reconciliation		0	5	10	15	20	
G.4. Control of Retroactive Changes		0	5	9	14	18	
G.5. Preventing Unauthorized Revisions to the Contract Budget Base (CBB)		0	5	10	15	20	
G.6. Over-Target Baseline (OTB) Authorization		0	3	6	9	11	
Sub-process G – Change Control, Column Frequency Totals		0	29	56	86	112	

Table 31 Sub-process H Score Sheet (Scheme B)

SUB-PROCESS H – MATERIAL MANAGEMENT							
		Maturity Level					
Attribute	N/A	1	2	3	4	5	Comments
H.1. Recording Actual Material Costs		0	3	7	10	14	
H.2. Material Performance		0	3	7	10	14	
H.3. Residual Material		0	2	4	6	8	
H.4. Material Price/Usage Variance		0	3	5	8	11	
H.5. Identification of Unit Costs and Lot Costs		0	2	4	5	7	
Sub-process H – Material Management, Column Frequency Totals		0	13	27	39	54	

Maturity Levels

N/A= Not Applicable	2 = Major Gaps	4 = No Gaps
1 = Not Yet Started	3 = Minor Gaps	5 = Best in Class

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Table 32 Sub-process I Score Sheet (Scheme B)

SUB-PROCESS I – SUBCONTRACT MANAGEMENT							
Attribute	**Maturity Level**						**Comments**
	N/A	**1**	**2**	**3**	**4**	**5**	
I.1. **Subcontract Identification and Requirements Flow Down**		0	3	6	9	12	
I.2. **Subcontractor Integration and Analysis**		0	4	7	11	14	
I.3. **Subcontract Oversight**		0	3	6	9	12	
Sub-process I – Subcontract Management, Column Frequency Totals		**0**	**10**	**19**	**29**	**38**	

Table 33 Sub-process J Score Sheet (Scheme B)

SUB-PROCESS J – RISK MANAGEMENT							
Attribute	**Maturity Level**						**Comments**
	N/A	**1**	**2**	**3**	**4**	**5**	
J.1. **Identify, Analyze and Manage Risk**		0	4	8	12	15	
J.2. **Risk Integration**		0	3	7	10	13	
Sub-process J – Risk Management, Column Frequency Totals		**0**	**7**	**15**	**22**	**28**	

Maturity Levels

N/A= Not Applicable	2 = Major Gaps	4 = No Gaps
1 = Not Yet Started	3 = Minor Gaps	5 = Best in Class

For better visualization of the score portions of each attribute relative to one another across the total 1000 points, a pie chart was formed for Scheme B, shown in Figure 30.
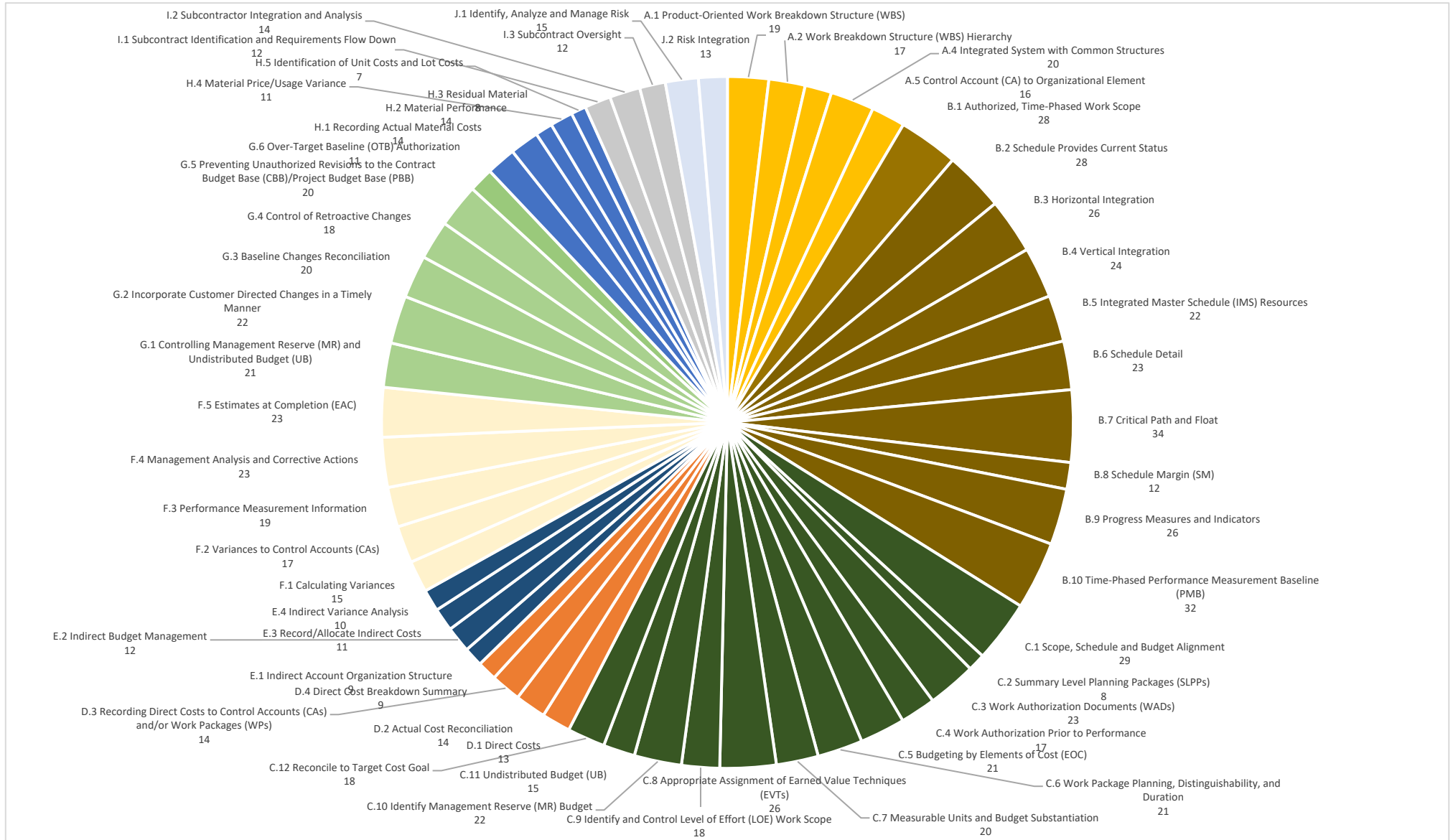
Figure 30 Scheme B Score Pie Chart

Moving forward, the research team compared Scheme A scores to Scheme B scores to identify issues, if any. The following tables show the results of the comparison followed by a discussion on Scheme B scores.

Scheme A vs. Scheme B Comparison

Table 34 Score Comparison Scheme A vs. Scheme B (sub-process)

Sub-process	Number of attributes	Total Sub-process Weight (Scheme A)	Total Sub-process Weight (Scheme B)	delta	% change
A	5	105	85	-20	-19%
B	10	157	256	99	63%
C	12	122	238	116	95%
D	4	79	50	-29	-37%
E	4	65	42	-23	-35%
F	5	120	97	-23	-19%
G	6	117	112	-5	-4%
H	5	66	54	-12	-18%
I	3	80	38	-42	-53%
J	2	89	28	-61	-69%

Table 35 Score Comparison Scheme A vs. Scheme B (sub-process A attributes)

Sub-process A (Organizing)				
Attribute	Scheme A	Scheme B	delta	% change
A.1	24	19	-5	-21%
A.2	21	17	-4	-19%
A.3	15	13	-2	-13%
A.4	25	20	-5	-20%
A.5	20	16	-4	-20%
Total:	105	85	-20	-19%

Table 36 Score Comparison Scheme A vs. Scheme B (sub-process B attributes)

Sub-process B (Planning and Scheduling)				
Attribute	Scheme A	Scheme B	delta	% change
B.1	17	28	11	65%
B.2	17	28	11	65%
B.3	16	26	10	63%
B.4	15	24	9	60%
B.5	13	22	9	69%
B.6	14	23	9	64%
B.7	21	34	13	62%
B.8	8	13	5	63%
B.9	16	26	10	63%
B.10	20	32	12	60%
Total:	157	256	99	63%

Table 37 Score Comparison Scheme A vs. Scheme B (sub-process C attributes)

Sub-process C (Budgeting and Work Authorization)				
Attribute	Scheme A	Scheme B	delta	% change
C.1	15	29	14	93%
C.2	4	8	4	100%
C.3	12	23	11	92%
C.4	9	17	8	89%
C.5	11	21	10	91%
C.6	11	21	10	91%
C.7	10	20	10	100%
C.8	13	26	13	100%
C.9	9	18	9	100%
C.10	11	22	11	100%
C.11	8	15	7	88%
C.12	9	18	9	100%
Total:	122	238	116	95%

Table 38 Score Comparison Scheme A vs. Scheme B (sub-process D attributes)

Sub-process D (Accounting Considerations)				
Attribute	Scheme A	Scheme B	delta	% change
D.1	21	13	-8	-38%
D.2	22	14	-8	-36%
D.3	22	14	-8	-36%
D.4	14	9	-5	-36%
Total:	79	50	-29	-37%

Table 39 Score Comparison Scheme A vs. Scheme B (sub-process E attributes)

Sub-process E (Indirect Budget and Cost Management)				
Attribute	Scheme A	Scheme B	delta	% change
E.1	14	9	-5	-36%
E.2	19	12	-7	-37%
E.3	16	11	-5	-31%
E.4	16	10	-6	-38%
Total:	65	42	-23	-35%

Table 40 Score Comparison Scheme A vs. Scheme B (sub-process F attributes)

Sub-process F (Analysis and Reporting)				
Attribute	Scheme A	Scheme B	delta	% change
F.1	18	15	-3	-17%
F.2	21	17	-4	-19%
F.3	23	19	-4	-17%
F.4	29	23	-6	-21%
F.5	29	23	-6	-21%
Total:	120	97	-23	-19%

Table 41 Score Comparison Scheme A vs. Scheme B (sub-process G attributes)

Sub-process G (Change Control)				
Attribute	Scheme A	Scheme B	delta	% change
G.1	21	21	0	0%
G.2	23	22	-1	-4%
G.3	21	20	-1	-5%
G.4	19	18	-1	-5%
G.5	21	20	-1	-5%
G.6	12	11	-1	-8%
Total:	117	112	-5	-4%

Table 42 Score Comparison Scheme A vs. Scheme B (sub-process H attributes)

Sub-process H (Material Management)				
Attribute	Scheme A	Scheme B	delta	% change
H.1	17	14	-3	-18%
H.2	17	14	-3	-18%
H.3	10	8	-2	-20%
H.4	13	11	-2	-15%
H.5	9	7	-2	-22%
Total:	66	54	-12	-18%

Table 43 Score Comparison Scheme A vs. Scheme B (sub-process I attributes)

Sub-process I (Subcontract Management)				
Attribute	Scheme A	Scheme B	delta	% change
I.1	25	12	-13	-52%
I.2	30	14	-16	-53%
I.3	25	12	-13	-52%
Total:	80	38	-42	-53%

Table 44 Score Comparison Scheme A vs. Scheme B (sub-process J attributes)

Sub-process J (Risk Management)				
Attribute	Scheme A	Scheme B	delta	% change
J.1	48	15	-33	-69%
J.2	41	13	-28	-68%
Total:	89	28	-61	-69%

Analyzing the Scheme B scores, the score pie chart, and the score comparison tables, a potential issue was identified in Scheme B; the scores in Scheme B were disproportionately impacted. See the below examples.

1. Large changes of sub-process scores (away from the relative importance levels established in the workshops) were observed in Scheme B scores versus Scheme A, including changes > 50% in four sub-processes: sub-process B (Planning and Scheduling), C (Budgeting and Work Authorization), I (Subcontract Management), and J (Risk Management).
2. Sub-processes B (Planning and Scheduling) and C (Budgeting and Work Authorization) constitute almost 50% of the total maturity score (491), compared to the workshop results which put their impact on the order of 30% of total EVMS maturity.
3. The scores of sub-processes I (Subcontract Management) and J (Risk Management) combined do not equal what one of them is supposed to score according to the workshop results.
4. When ranking sub-process scores, rankings differed versus what was provided at the workshops.

Therefore, both Schemes A and B had issues where, in Scheme A, many attribute scores were inflated, and in Scheme B sub-process rankings differed largely versus workshop results.

In order to address these issues, the authors searched for a scheme that stands in a better shape than Scheme A and Scheme B, i.e., that could better represent the workshop results. This new Scheme would moderate the extremes of Schemes A and B. Based on the feedback from the research team (when targeting a new scheme), the authors developed a set of rules to follow to remain as consistent as possible with the workshop results in the new scheme.

For this reason, the authors performed 101 different iterations (scenarios/schemes) moving between Schemes A and B by incrementally changing scores from Scheme A by 1%. For instance, the first iteration (i.e., scenario 1) represents 1% Scheme A score and 99% Scheme

B score per each attribute. For example, A.1 Scheme A score was 23.73 (Figure 25), and A.1 Scheme B score was 19.18 (Figure 28). Scenario 1 score for attribute A.1 results into 19.22 (23.73×1% + 19.18×99%). Figure 31 shows the plot of the attribute scores in Scheme A and Scheme B. The red and blue lines are the boundaries that indicate the bounded area where a potential scheme is targeted.
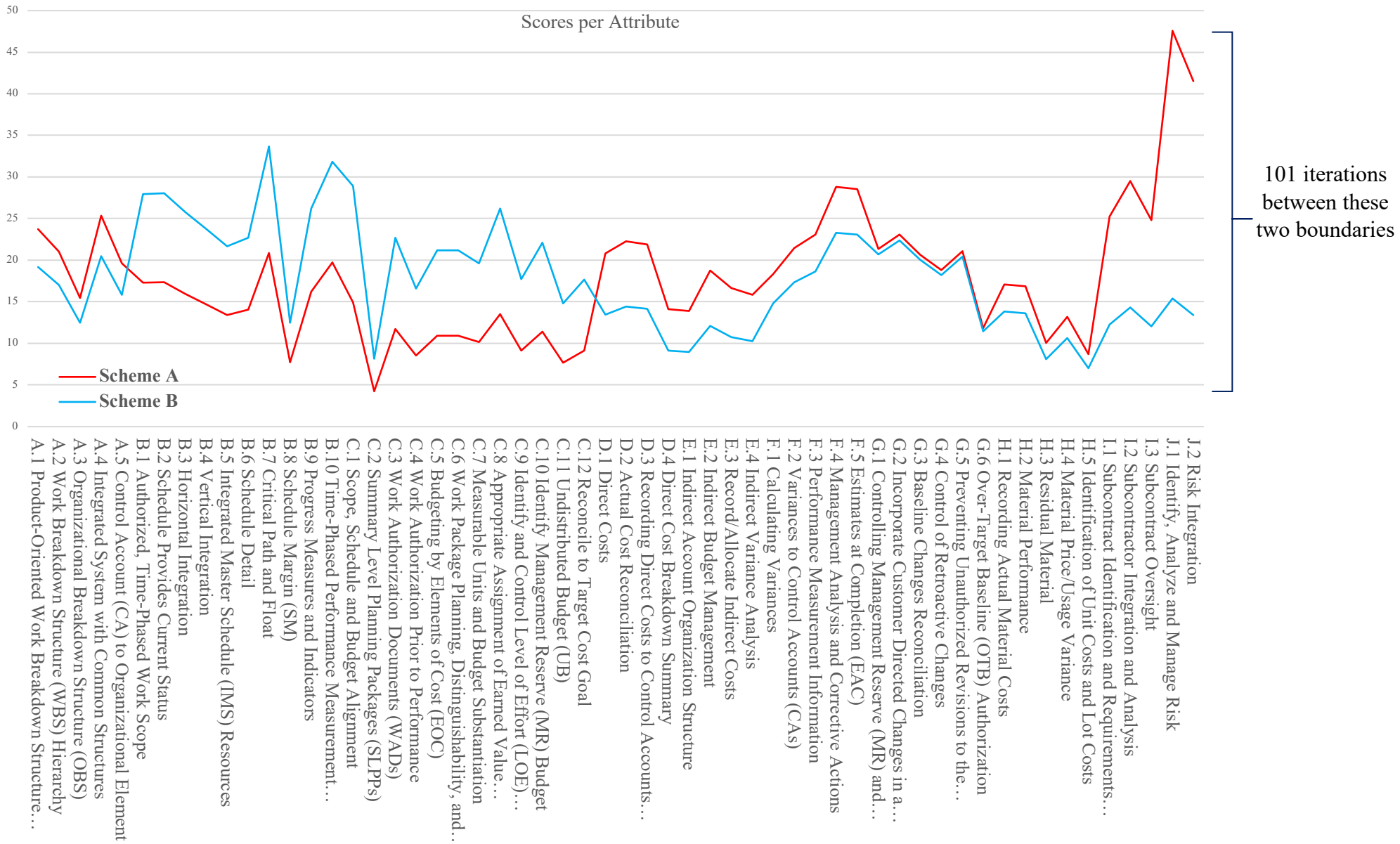
Figure 31 Scores per Attribute (Scheme A and B)

Based on the feedback of the research team, the authors set the following rules to find the suitable scheme from the 101 iterations:

1. *Rule #1:* **Ensure that the relative importance of sub-processes (set by the workshop participants) is maintained**. For example, see Figure 32, since sub-process B (Planning and Scheduling) ranks 1st (Appendix J), it maintains 1st rank in any new Scenario (scheme). Small rank changes are allowed as long as each sub-process remains in its original band (i.e., range of rank orders). For example, sub-processes J, I, D, have close average weights (Appendix J), therefore sub-process D can rank 6th, 7th, or 8th, but cannot have a rank which falls in another band. These bands were selected based on the sub-process average weights that are close to each other that were identified in the results of the workshops (Appendix J). The following figure illustrates these ranges by splitting the sub-processes into four "bands", varying from "Less important", to "Important", "Very important", and "Most important".
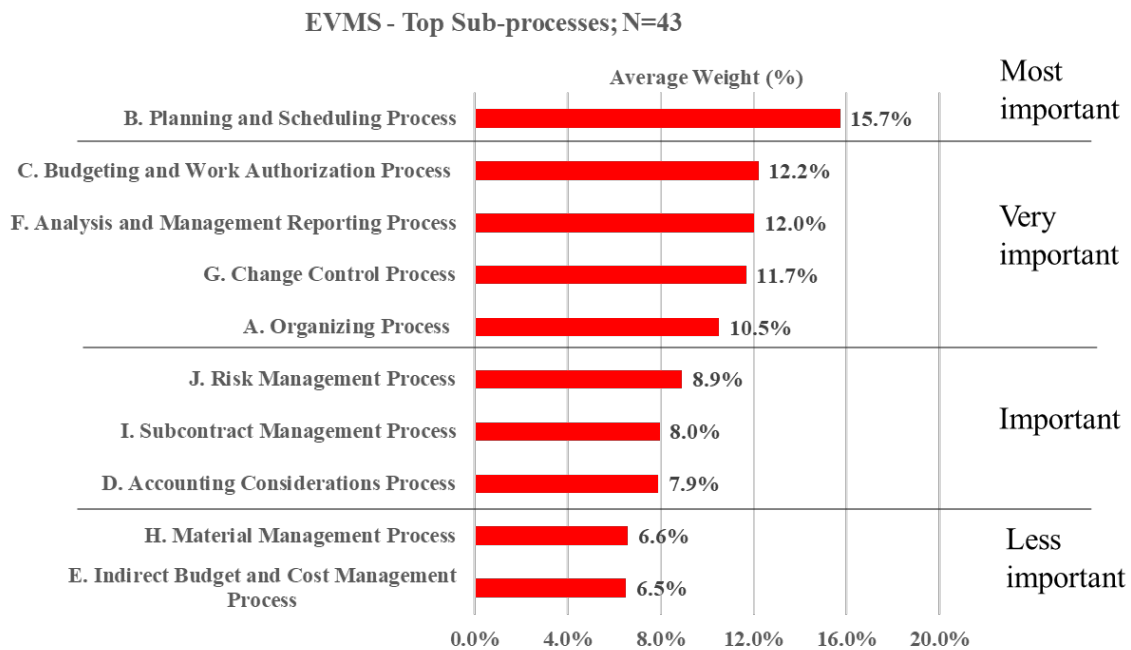
Figure 32 Sub-process Ranks as per Workshop Results

Table 45 illustrates Rule #1 in relation to all the sub-processes.

Table 45 Sub-process Ranks (Related to Rule #1)

Sub-process	Workshop Rank (Scheme A)	Band* (Rule #1)
A (organizing)	5	Rank 2 to 5
B (Planning and Scheduling)	1	Stays same
C (Budgeting and Work Authorization)	2	Rank 2 to 5
D (Accounting Considerations)	8	Rank 6 to 8
E (Indirect Budget and Cost Management)	10	Rank 9 to 10
F (Analysis and Management Reporting)	3	Rank 2 to 5
G (Change Control)	4	Rank 2 to 5
H (Material Management)	9	Rank 9 to 10
I (Subcontract Management)	7	Rank 6 to 8
J (Risk Management)	6	Rank 6 to 8
*Band represents the range of rank orders, where the sub-process rank can vary.		

2. _Rule #2:_ **Reduce the inflated attribute scores as long as Rule #1 is maintained**.

The completion of the 101 different iterations (scenarios) between Schemes A and B with a 1% incremental score change from Scheme A resulted into the following list of scenarios, going from Scenario #0 to Scenario #100 (Figure 33), where, Scenario #100 represents Scheme A, and Scenario #0 represents Scheme B.

Scenario #	0	1	...	33	34	35	36	...	52	53	54	55	56	57	...	96	97	98	99	100
% of Scheme A	0%	1%	...	33%	34%	35%	36%	...	52%	53%	54%	55%	56%	57%	...	96%	97%	98%	99%	100%
% of Scheme B	100%	99%	...	67%	66%	65%	64%	...	48%	47%	46%	45%	44%	43%	...	4%	3%	2%	1%	0%

Figure 33 101 Iterations between Scheme A and B

After analyzing the scores in each of the 101 iterations, the authors identified that Sceniario #52 best satisfies the rules stated above for two reasons explained next. Note: In Scenario #52, each of the attirbute scores are calculated as follows.

Equation (5): Scenario #52 level 5 score:

Scenario #52 score = 52% Scheme A score + 48% Scheme B score

First, according to Figure 34, the scenarios #52 to #100 comply with the Rule #1; each sub-process still ranks within its idenfied band.

Scenario #	0	1	...	33	34	35	36	...	52	53	54	55	56	57	...	96	97	98	99	100
% of Scheme A	0%	1%	...	33%	34%	35%	36%	...	52%	53%	54%	55%	56%	57%	...	96%	97%	98%	99%	100%
% of Scheme B	100%	99%	...	67%	66%	65%	64%	...	48%	47%	46%	45%	44%	43%	...	4%	3%	2%	1%	0%

Scenarios #52 and above comply with the Rule #1
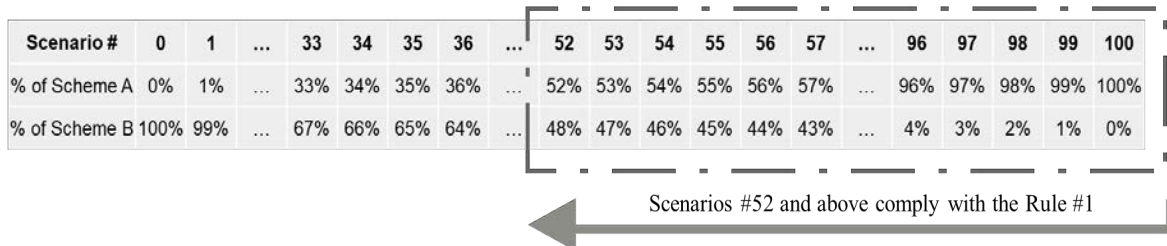
Figure 34 Scenarios between Scheme A and B complying with Rule #1

Table 46 illustrates how in Scenario #52, the sub-process rankings differed from the ranks of Scheme A (workshop results).

Table 46 Sub-process Ranks in Scenario #52

Sub-process	Workshop Rank (Scheme A)	Scenario #52
A (organizing)	5	5
B (Planning and Scheduling)	1	1
C (Budgeting and Work Authorization)	2	2
D (Accounting Considerations)	8	**6**
E (Indirect Budget and Cost Management)	10	10
F (Analysis and Management Reporting)	3	**4**
G (Change Control)	4	**3**
H (Material Management)	9	9
I (Subcontract Management)	7	**8**
J (Risk Management)	6	**7**
Note: Bolded numbers are for the sub-process ranks that differed from Scheme A.		

These results show that in case of Scenario #52, the rankings differed from the workshop results for five sub-processes only, yet they stayed within the idenfied bands in Rule #1 (Table 45).

Second, in Scenario #52, the inflation in attribute scores versus Scheme A was minimized. See Figure 35 (Note: in this Figure, the name of J.1 attribute is "Identify, Analyze and Manage Risk,"; and the name of the C.1 attribute is "Scope, Schedule and Budget Alignment.")

Scenario #:	0 (Scheme B)	33	51	52	53	54	96	100 (Scheme A)
Scenario score = % Scheme A score + % Scheme B score	0% A + 100% B	33% A + 67% B	51% A + 49% B	52% A + 48% B	53% A + 47% B	54% A + 46% B	96% A + 4% B	100% A + 0% B
Ranking stays within the identified bands	No	No	No	**Yes**	Yes	Yes	Yes	Yes
C.1 score − J.1 score (maximum score in sub-process C minus maximum score in sub-process J)	+14	-2	-10	-10	-11	-11	-31	-33
Inflation of attribute scores versus Scheme A				Min	↑	↑	↑↑	Max

Figure 35 Scenarios between Scheme A and B Complying with Rule #2

In summary, in Scenario #52, all of the sub-processes maintained their ranking within the identified set of bands. Scenario #52 was the best Scenario since it was the furthest from Scheme A, thus, minimizing inflated attribute scores. Moreover, all changes in sub-process scores versus Scheme A were less than 50% (average change = 5%).

Sharing these results with the research team, the proposed Scenario #52 was selected to be the scheme to use to generate the final attribute scores. For example, recall attribute A.1 ("Product-Oriented Work Breakdown Structure (WBS)") level 5 score in Scheme A was 23.73 and score in Scheme B was 19.18. In the new final Scheme, its new score is 21.54 (result of 52% × 23.73 + 48% × 19.18), rounded to 22. This step was repeated for all the attributes and the following tables represent the final score results.

Final Score Sheets

Table 47 Sub-process A Final Score Sheet

SUB-PROCESS A – ORGANIZING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
A.1. Product-Oriented Work Breakdown Structure (WBS)		0	5	11	16	22	
A.2. Work Breakdown Structure (WBS) Hierarchy		0	5	10	14	19	
A.3. Organizational Breakdown Structure (OBS)		0	4	7	11	14	
A.4. Integrated System with Common Structures		0	6	11	17	23	
A.5. Control Account (CA) to Organizational Element		0	4	9	13	18	
Sub-process A – Organizing, Column Frequency Totals		**0**	**24**	**48**	**71**	**96**	

Table 48 Sub-process B Final Score Sheet

SUB-PROCESS B – PLANNING AND SCHEDULING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
B.1. Authorized, Time-Phased Work Scope		0	6	11	17	22	
B.2. Schedule Provides Current Status		0	6	11	17	22	
B.3. Horizontal Integration		0	5	10	15	21	
B.4. Vertical Integration		0	5	10	14	19	
B.5. Integrated Master Schedule (IMS) Resources		0	4	9	13	17	
B.6. Schedule Detail		0	5	9	14	18	
B.7. Critical Path and Float		0	7	13	20	27	
B.8. Schedule Margin (SM)		0	2	5	7	10	
B.9. Progress Measures and Indicators		0	5	11	16	21	
B.10. Time-Phased Performance Measurement Baseline (PMB)		0	6	13	19	25	
Sub-process B – Planning and Scheduling, Column Frequency Totals		**0**	**51**	**102**	**152**	**202**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 49 Sub-process Final Score Sheet

SUB-PROCESS C – BUDGETING AND WORK AUTHORIZATION							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
C.1. Scope, Schedule and Budget Alignment		0	5	11	16	22	
C.2. Summary Level Planning Packages (SLPPs)		0	2	3	5	6	
C.3. Work Authorization Documents (WADs)		0	4	8	13	17	
C.4. Work Authorization Prior to Performance		0	3	6	9	12	
C.5. Budgeting by Elements of Cost (EOC)		0	4	8	12	16	
C.6. Work Package Planning, Distinguishability, and Duration		0	4	8	12	16	
C.7. Measurable Units and Budget Substantiation		0	4	7	11	15	
C.8. Appropriate Assignment of Earned Value Techniques (EVTs)		0	5	10	15	20	
C.9. Identify and Control Level of Effort (LOE) Work Scope		0	3	7	10	13	
C.10. Identify Management Reserve (MR) Budget		0	4	8	12	17	
C.11. Undistributed Budget (UB)		0	3	6	8	11	
C.12. Reconcile to Target Cost Goal		0	3	7	10	13	
Sub-process C – Budgeting and Work Authorization, Column Frequency Totals		**0**	**44**	**89**	**133**	**178**	

Table 50 Sub-process D Final Score Sheet

SUB-PROCESS D – ACCOUNTING CONSIDERATIONS							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
D.1. Direct Costs		0	4	9	13	17	
D.2. Actual Cost Reconciliation		0	5	9	14	18	
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)		0	5	9	14	18	
D.4. Direct Cost Breakdown Summary		0	3	6	9	12	
Sub-process D – Accounting Considerations, Column Frequency Totals		**0**	**17**	**33**	**50**	**65**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 51 Sub-process E Final Score Sheet

SUB-PROCESS E – INDIRECT BUDGET AND COST MANAGEMENT							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
E.1. Indirect Account Organization Structure		0	3	6	9	12	
E.2. Indirect Budget Management		0	4	8	12	16	
E.3. Record/Allocate Indirect Costs		0	3	7	10	14	
E.4. Indirect Variance Analysis		0	3	7	10	13	
Sub-process E – Indirect Budget and Cost Management, Column Frequency Totals		**0**	**13**	**28**	**41**	**55**	

Table 52 Sub-process F Final Score Sheet

SUB-PROCESS F – ANALYSIS AND MANAGEMENT REPORTING							
		Maturity Level					
Attribute	**N/A**	**1**	**2**	**3**	**4**	**5**	**Comments**
F.1. Calculating Variances		0	4	8	12	17	
F.2. Variances to Control Accounts (CAs)		0	5	10	15	19	
F.3. Performance Measurement Information		0	5	10	16	21	
F.4. Management Analysis and Corrective Actions		0	7	13	20	26	
F.5. Estimates at Completion (EAC)		0	6	13	19	26	
Sub-process F – Analysis and Management Reporting, Column Frequency Totals		**0**	**27**	**54**	**82**	**109**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Table 53 Sub-process G Final Score Sheet

SUB-PROCESS G – CHANGE CONTROL							
Attribute	N/A	1	2	3	4	5	Comments
G.1. Controlling Management Reserve (MR) and Undistributed Budget (UB)		0	5	11	16	21	
G.2. Incorporate Customer Directed Changes in a Timely Manner		0	6	11	17	23	
G.3. Baseline Changes Reconciliation		0	5	10	15	20	
G.4. Control of Retroactive Changes		0	5	9	14	19	
G.5. Preventing Unauthorized Revisions to the Contract Budget Base (CBB)		0	5	10	16	21	
G.6. Over-Target Baseline (OTB) Authorization		0	3	6	9	12	
Sub-process G – Change Control, Column Frequency Totals		**0**	**29**	**57**	**87**	**116**	

Table 54 Sub-process H Final Score Sheet

SUB-PROCESS H – MATERIAL MANAGEMENT							
Attribute	N/A	1	2	3	4	5	Comments
H.1. Recording Actual Material Costs		0	4	8	12	15	
H.2. Material Performance		0	4	8	11	15	
H.3. Residual Material		0	2	5	7	9	
H.4. Material Price/Usage Variance		0	3	6	9	12	
H.5. Identification of Unit Costs and Lot Costs		0	2	4	6	8	
Sub-process H – Material Management, Column Frequency Totals		**0**	**15**	**31**	**45**	**59**	

Maturity Levels

N/A= Not Applicable   2 = Major Gaps   4 = No Gaps
1 = Not Yet Started   3 = Minor Gaps   5 = Best in Class

Table 55 Sub-process I Final Score Sheet

SUB-PROCESS I – SUBCONTRACT MANAGEMENT							
Attribute	**N/A**	**Maturity Level**					**Comments**
		1	**2**	**3**	**4**	**5**	
I.1. **Subcontract Identification and Requirements Flow Down**		0	5	9	14	19	
I.2. **Subcontractor Integration and Analysis**		0	6	11	17	22	
I.3. **Subcontract Oversight**		0	5	9	14	19	
Sub-process I – Subcontract Management, Column Frequency Totals		**0**	**16**	**29**	**45**	**60**	

Table 56 Sub-process J Final Score Sheet

SUB-PROCESS J – RISK MANAGEMENT							
Attribute	**N/A**	**Maturity Level**					**Comments**
		1	**2**	**3**	**4**	**5**	
J.1. **Identify, Analyze and Manage Risk**		0	8	16	24	32	
J.2. **Risk Integration**		0	7	14	21	28	
Sub-process J – Risk Management, Column Frequency Totals		**0**	**15**	**30**	**45**	**60**	

Maturity Levels

N/A= Not Applicable	**2 = Major Gaps**	**4 = No Gaps**
1 = Not Yet Started	**3 = Minor Gaps**	**5 = Best in Class**

Figure 36 shows the plot of the attribute scores in Scheme A, Scheme B, and Scenario #52 which stands between them.
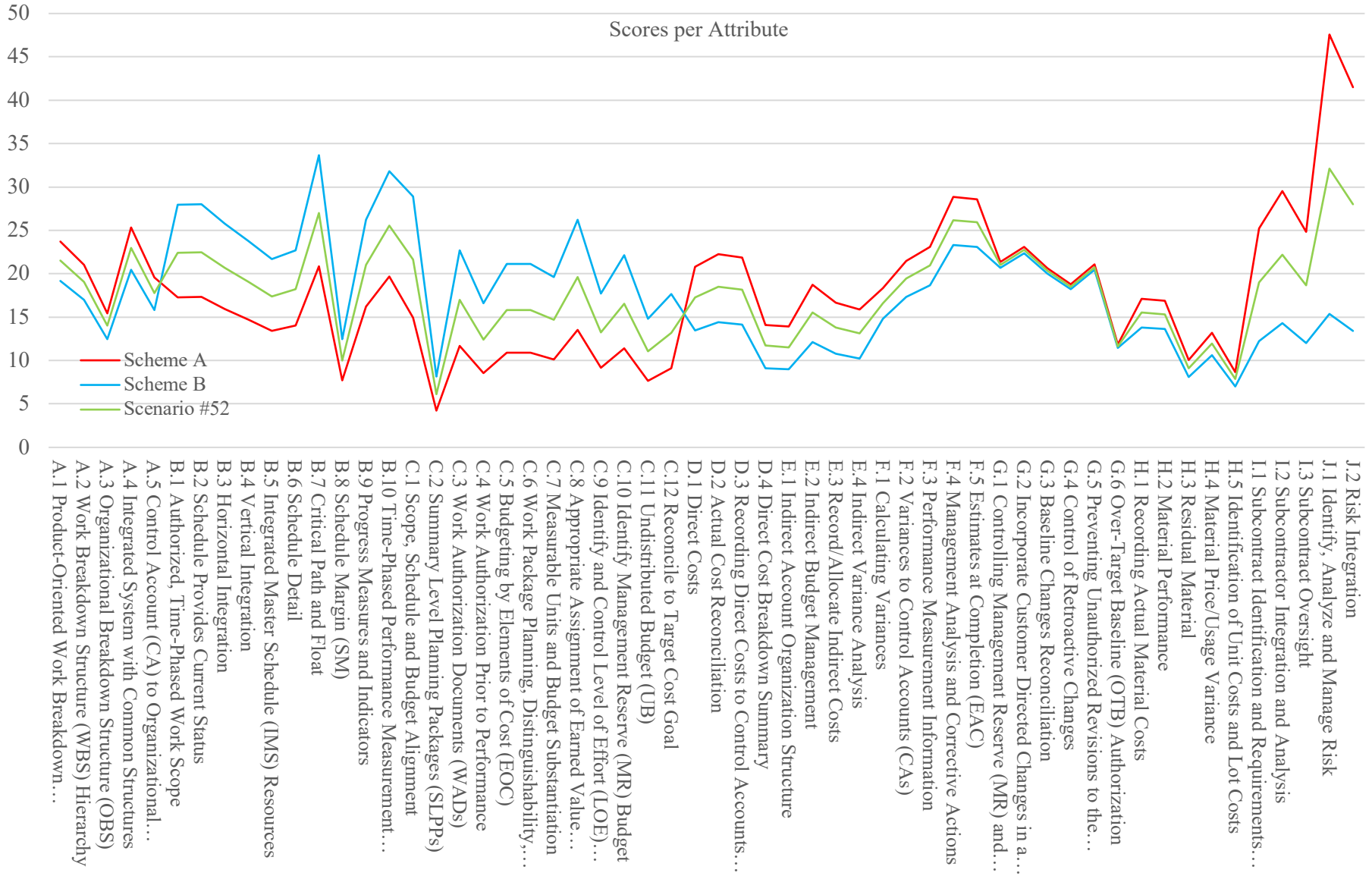
Figure 36 Plot of the Attribute Scores

For better visualization of the score portions of each attribute relative to one another across the total 1,000 points, a pie chart was developed for the final Scheme, shown in Figure 37.
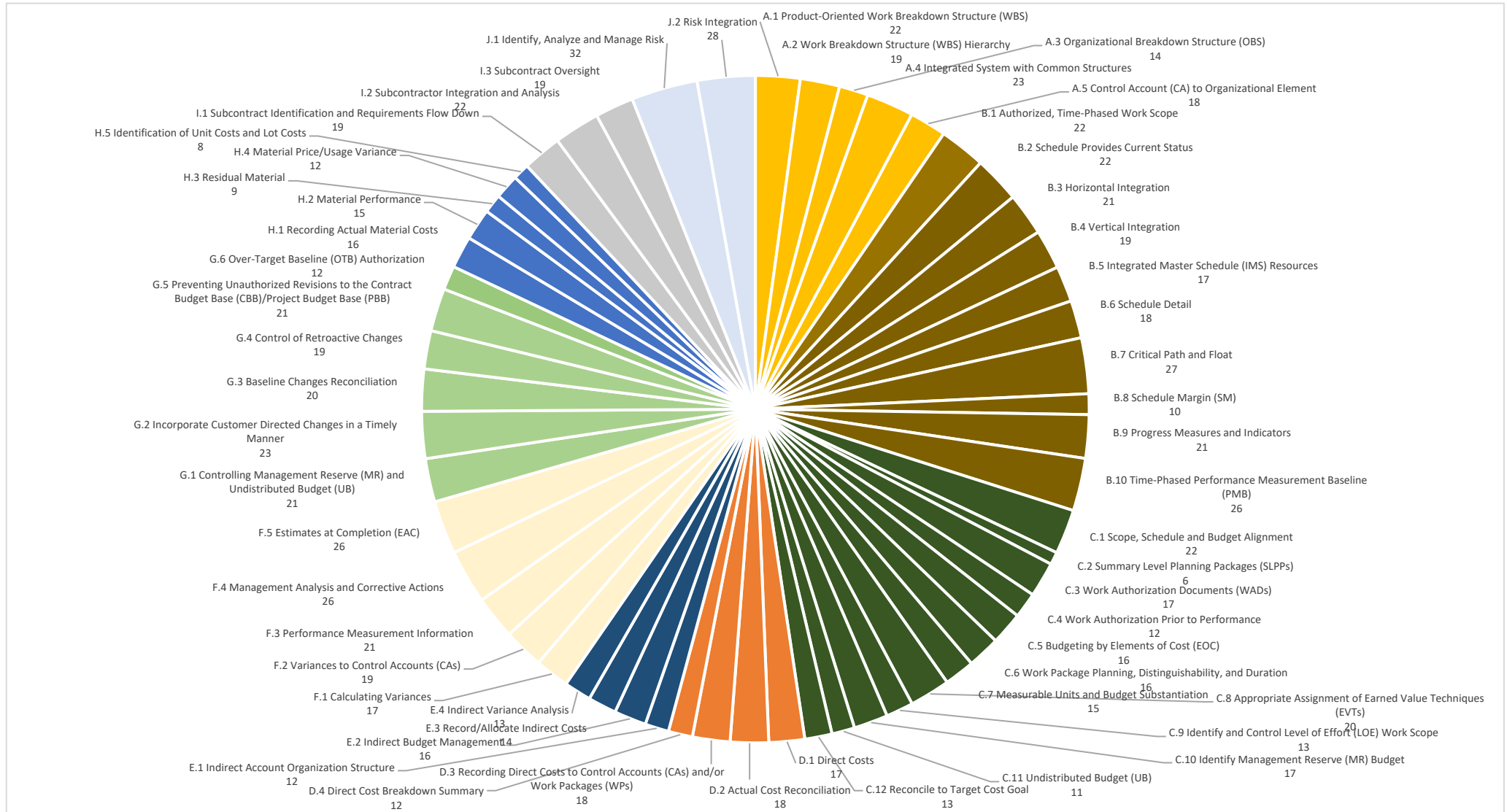
Figure 37 Final Scheme Score Pie Chart

N/A Attributes

In addition to weighting the attributes and sub-processes, the participants were asked to weigh an attribute as "0" for any attribute that may be considered as not applicable on a project or a program. Therefore, based on the feedback of the workshop participants, the following list shows the attributes that were "identified" as not applicable on a project or a program. The numbers in parentheses represent the frequency of the responses that said the attribute can be N/A.

- A.1. Product-Oriented Work Breakdown Structure (WBS) (1)
- B.5. Integrated Master Schedule (IMS) Resources (3)
- B.8. Schedule Margin (SM) (8)
- B.9. Progress Measures and Indicators (2)
- C.1. Scope, Schedule and Budget Alignment (1)
- C.2. Summary Level Planning Packages (SLPPs) (9)
- C.4. Work Authorization Prior to Performance (1)
- C.5. Budgeting by Elements of Cost (EOC) (1)
- C.7. Measurable Units and Budget Substantiation (2)
- C.10. Identify Management Reserve (MR) Budget (1)
- C.11. Undistributed Budget (UB) (2)
- C.12. Reconcile to Target Cost Goal (1)
- E.2. Indirect Budget Management (1)
- E.3. Record/Allocate Indirect Costs (1)
- E.4. Indirect Variance Analysis (3)
- F.1. Calculating Variances (1)
- G.1 Controlling Management Reserve (MR) and Undistributed Budget (UB) (1)
- G.6. Over-Target Baseline (OTB) Authorization (6)
- H.3. Residual Material (4)
- H.4. Material Price/Usage Variance (2)
- H.5. Identification of Unit Costs and Lot Costs (9)
- J.2. Risk Integration (1)
- Sub-process C. Budgeting and Work Authorization Process (2)
- Sub-process D. Accounting Considerations Process (1)
- Sub-process E. Indirect Budget and Cost Management Process (4)
- Sub-process F. Analysis and Management Reporting Process (2)
- Sub-process G. Change Control Process (2)
- Sub-process H. Material Management Process (2)
- Sub-process I. Subcontract Management Process (2)
- Sub-process J. Risk Management Process (4)

Based on these results, a list of twenty-two attributes and most of the sub-processes (eight) were vetted to be attributes and sub-processes that may be not applicable on a given project or a program when applying EVMS. Taking these results into consideration, the research team agreed that the IP2M METRR tool score sheets should allow the user to indicate the attribute(s) (out of the 56 attributes) as "N/A" for those attributes that do not apply on the assessed project or program.

6. Conclusions

The research results presented in this report fulfilled the objective of developing a novel assessment tool that evaluates the maturity around an earned value management system aiming for a favorable execution of integrated project/program management.

The authors, together with the research team, and based on an extensive literature review and industry survey results, formed an initial tool draft with a set of 56 EVMS maturity attributes that make up the ten EVMS sub-processes (i.e., Organizing, Planning and Scheduling, Budgeting and Work Authorization, Accounting Considerations, Indirect Budget and Cost Management, Analysis and Management Reporting, Change Control, Material Management, Subcontract Management, and Risk Management). The tool includes 56 maturity attribute tables, each containing attribute name, description, and narratives for each of the different maturity levels (level 1 to 5, with 5 being the highest maturity). The tool was then improved and refined based on the data collected from 56 industry professionals (note that it was a coincidence that the workshop participant numbered equaled the number of attributes in the tool) representing 32 unique organizations and through four industry workshops. The data collected from the workshops also helped finalize the relative weights associated with each maturity attribute in terms of importance, as well as scores for the different maturity levels. The results showed that certain maturity attributes are more important than others, for an effective EVMS.

The authors with the support of the research team addressed a total of 859 comments received from the industry workshops regarding the attribute names, their descriptions, and the narratives of the different maturity levels. Taking into consideration the valuable feedback from the maturity workshop participants and the research team, the authors proved that the tool is practical, effective, and easy to use. Based on this data-driven tool, the authors conclude that the components of the EVMS maturity can be defined and measured.

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APPENDICES

Appendix A. Workshop Participants' Organizations

Argonne National Lab (ANL)
AzTech International
BAE Systems
Booz Allen Hamilton
CACI International
Central Plateau Cleanup Company
ClearPlan Consulting
Comcast
Deltek
Encore Analytics
Fermi National Accelerator Laboratory (FNAL)
Fluor
General Atomics Aeronautical Systems
Humphreys & Associates
Idaho National Laboratory (INL)
Jacobs
Johns Hopkins University Applied Physics Laboratory
Lockheed Martin
Los Alamos National Lab (LANL)
National Aeronautics and Space Administration (NASA)
National Scientific Foundation (NSF)
Naval Postgraduate School (NPS)
Offshore at Avangrid Renewables
Olde Stone Consulting, LLC
Otenet
PEO Ground Combat Systems
Tecolote Research, Inc.
US Air Force
US Army
US Department of Defense
US Department of Energy
US Navy

Note: The organization names are in alphabetical order.

Appendix B. Sample Qualtrics Questionnaire – Maturity Workshop

Overview. The Earned Value Management System (EVMS) Maturity and Environment Total Rating (METR) is an assessment mechanism being developed as part of a DOE-sponsored Joint Research Study led by the Arizona State University (ASU) and representing 15+ government and industry organizations. The envisioned tool will assess a spectrum of EVMS maturity and environment issues centered around the 32 EIA-748 EVMS Guidelines.

The purpose of this workshop is to review and provide feedback on the Maturity assessment section of the draft EVMS METR tool.

Confidentiality   Statement:
All data provided to ASU in support of this research activity will be considered confidential information. Individual organization data will not be communicated in any form to any party other than the ASU authorized academic researchers. Any data or analyses that are shared with others or published will represent summaries of data from multiple participating organizations that have been aggregated in a way that will preclude identification of proprietary data. If you have any questions, please contact Dr. G. Edward Gibson, Jr. (egibson4@asu.edu) or Dr. Mounir El Asmar (asmar@asu.edu).

Please note that when you answer questions, you must also click on the **NEXT button (Right Arrow)** to move to the following screen.

○   Name: _____

Q1 Please indicate your employer type.

○   Government contractor

○   Government

○   Consultant

○   Manufacturer/Constructor

○   Other (software developer, World Bank, non-profit organization, etc.); please specify. _____

Q2 Please provide your typical employment role.

- ○ Project controls management

- ○ Project/program management

- ○ Compliance management

- ○ Executive or senior management

- ○ Consulting

- ○ Finance

- ○ Engineering & systems engineering

- ○ Other (contracting, control accounts management or other); please specify.

  _____

Q3 How many years of Earned Value Management (EVM) experience do you have in total?

- ○ < 5 years

- ○ 5 to 10 years

- ○ 11 to 15 years

- ○ 16 to 20 years

- ○ 21 to 25 years

- ○ > 25 years

Q4 Think of a current or past EVMS application on a project/program that you are or were involved with. You will use this application as your anchor.

○ Please provide the name of the project/program (e.g., USS Enterprise):

_____

○ What is the approximate project/program total cost? ($ value; e.g., $60M)

_____

○ What is the approximate date for the start of planning? (Month and Year)

_____

○ What is the approximate date for the end of execution? (Month and Year)

_____

Q5 Was the information provided in Q4 a Project or a Program?

○ Project

○ Program

Q6 **Process E. Indirect Budget and Cost Management.**
 Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under E.2 level 3"; or "I do not agree with the third paragraph under E.3 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

[*] [⤢]

Q7 This question is focused on the attributes that make up the **Indirect Budget and Cost Management Process** (Process E). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Indirect Budget and Cost Management Process (Process E). When weighting, think about your anchor

project/program and allocate percentages accordingly. The total number of points should sum up to 100.

        E.1 Indirect Account Organization Structure : _____

        E.2 Indirect Budget Management : _____

        E.3 Record/Allocate Indirect Costs : _____

        E.4 Indirect Variance Analysis : _____

Total : _____

Q8 Process F. Analysis and Management Reporting.
 Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under F.1 level 2"; or "I do not agree with the third paragraph under F.3 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

Q9 This question is focused on the attributes that make up the **Analysis and Management Reporting Process** (Process F). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Analysis and Management Reporting Process (Process F). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

        F.1 Calculating Variances : _____

        F.2 Variances to Control Accounts (CAs) : _____

        F.3 Performance Measurement Information : _____

        F.4 Management Analysis and Corrective Actions : _____

        F.5 Estimates at Completion (EAC) : _____

Total : _____

Q10 **Process G. Change Control.**
 Please provide your *actionable comments* or *suggested edits* related to any attributes that

make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under G.2 level 4"; or "I do not agree with the third paragraph under G.6 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

<center>✳   ⤨</center>

Q11 This question is focused on the attributes that make up the **Change Control Process** (Process G). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Change Control Process (Process G). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

        G.1 Controlling Management Reserve (MR) and Undistributed Budget (UB) : _____

        G.2 Incorporate Customer Directed Changes in a Timely Manner : _____

        G.3 Baseline Changes Reconciliation : _____

        G.4 Control of Retroactive Changes : _____

        G.5 Preventing Unauthorized Revisions to the Contract Budget Base (CBB) : _____

        G.6 Over-Target Baseline (OTB) Authorization : _____

Total : _____

Q12 **Process H. Material Management.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under H.3 level 3"; or "I do not agree with the third paragraph under H.5 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

<center>✳   ⤨</center>

Q13 This question is focused on the attributes that make up the **Material Management Process** (Process H). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Material Management Process (Process H). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

H.1 Recording Actual Material Costs : _____

H.2 Material Performance : _____

H.3 Residual Material : _____

H.4 Material Price/Usage Variance : _____

H.5 Identification of Unit Costs and Lot Costs : _____

Total : _____

Q14 **Process I. Subcontract Management.**
 Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under I.1 description"; or "I do not agree with the third paragraph under I.3 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

Q15 This question is focused on the attributes that make up the **Subcontract Management Process** (Process I). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Subcontract Management Process (Process I). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

I.1 Subcontract Identification and Requirements Flow Down : _____

I.2 Subcontractor Integration and Analysis : _____

I.3 Subcontract Oversight : _____

Total : _____

Q16 **Process J. Risk Management.**
 Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under J.1. level 2"; or "I do not agree with the third paragraph under J.2. Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

Q17 This question is focused on the attributes that make up the **Risk Management Process** (Process J). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Risk Management Process (Process J). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

J.1 Identify, Analyze and Manage Risk : _____

J.2 Risk Integration : _____

Total : _____

Q18 **Process A. Organizing.**
 Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under A.2 level 3"; or "I do not agree with the third paragraph under A.4 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

Q19 This question is focused on the attributes that make up the **Organizing Process** (Process A). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Organizing Process (Process A).

When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

A.1 Product-Oriented Work Breakdown Structure (WBS) : _____

A.2 Work Breakdown Structure (WBS) Hierarchy : _____

A.3 Organizational Breakdown Structure (OBS) : _____

A.4 Integrated System with Common Structures : _____

A.5 Control Account (CA) to Organizational Element : _____

Total : _____

Q20 **Process B. Planning and Scheduling.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under B.3 description"; or "I do not agree with the third paragraph under B.10 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

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* ⤧

Q21
This question is focused on the attributes that make up the **Planning and Scheduling Process** (Process B). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Planning and Scheduling

Process (Process B). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

B.1 Authorized, Time-Phased Work Scope : _____

B.2 Schedule Provides Current Status : _____

B.3 Horizontal Integration : _____

B.4 Vertical Integration : _____

B.5 Integrated Master Schedule (IMS) Resources : _____

B.6 Schedule Detail : _____

B.7 Critical Path and Float : _____

B.8 Schedule Margin (SM) : _____

B.9 Progress Measures and Indicators : _____

B.10 Time-Phased Performance Measurement Baseline (PMB) : _____

Total : _____

Q22 **Process C. Budgeting and Work Authorization.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under C.5 level 3"; or "I do not agree with the third paragraph under C.7 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

Q23 This question is focused on the attributes that make up the **Budgeting and Work Authorization Process** (Process C). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Budgeting and Work Authorization Process (Process C). When weighting, think about your anchor

project/program and allocate percentages accordingly. The total number of points should sum up to 100.

C.1 Scope, Schedule and Budget Alignment : _____

C.2 Summary Level Planning Packages (SLPPs) : _____

C.3 Work Authorization Documents (WADs) : _____

C.4 Work Authorization Prior to Performance : _____

C.5 Budgeting by Elements of Cost (EOC) : _____

C.6 Work Package Planning, Distinguishability, and Duration : _____

C.7 Measurable Units and Budget Substantiation : _____

C.8 Appropriate Assignment of Earned Value Techniques (EVTs) : _____

C.9 Identify and Control Level of Effort (LOE) Work Scope : _____

C.10 Identify Management Reserve (MR) Budget : _____

C.11 Undistributed Budget (UB) : _____

C.12 Reconcile to Target Cost Goal : _____

Total : _____

Q24 **Process D. Accounting Considerations.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under D.1 level 3"; or "I do not agree with the third paragraph under D.1 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

_____

_____

Q25 This question is focused on the attributes that make up the **Accounting Considerations Process** (Process D). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Accounting Considerations Process (Process D). When weighting, think about your

anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

D.1 Direct Costs : _____

D.2 Actual Cost Reconciliation : _____

D.3 Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs) : _____

D.4 Direct Cost Breakdown Summary : _____

Total : _____

Q26 This question is focused on the relative importance of the ten processes that typically make up an EVMS. Please allocate 100 points divided among these processes based on the relative impact of each process as related to overall EVMS maturity. When weighting, think about your anchor project/program and allocate percentages accordingly. Allocating more points to a process reflects a higher impact on EVMS Maturity. The total number of points should sum up to 100.

An **EVMS Process** is defined as a series of interrelated tasks that, together, transform inputs into a system to achieve Earned Value Management (EVM). The following ten core processes collectively make up an EVMS.

A. Organizing Process (WBS; WBS Hierarchy; OBS; Integrated System; CA to Organizational Element) : _____

B. Planning and Scheduling Process (Time-Phased Work Scope; Schedule; Horizontal and Vertical Integration; IMS Resources; Schedule Detail; CP and Float; SM; Progress Measures; PMB) : _____

C. Budgeting and Work Authorization Process (Alignment of Scope, Schedule, Budget; SLPPs; WADs; Budgeting by EOC; WP; Units and Budget

Substantiation; EVTs; LOE; Identify MR; UB; Reconcile Target Cost Goal) : _____

D. Accounting Considerations Process (Direct Costs; Actual Cost Reconciliation; WPs; Direct Cost Breakdown Summary) : _____

E. Indirect Budget and Cost Management Process (Indirect Account; Indirect Budget and Cost; Indirect Variance Analysis) : _____

F. Analysis and Management Reporting Process (Calculating Variances; Variances to CAs; Performance Measurement Information; Management Analysis and Corrective Actions; EAC) : _____

G. Change Control Process (Control MR and UB; Incorporate Customer Directed Changes; Baseline Changes Reconciliation; Control Retroactive Changes; Unauthorized Revisions to CBB) : _____

H. Material Management Process (Recording Actual Material Costs; Material Performance; Residual; Price/Usage Variance; Unit Costs and Lot Costs) : _____

I. Subcontract Management Process (Identification and Requirements Flow Down; Integration and Analysis; Oversight) : _____

J. Risk Management Process (Identify, Analyze, and Manage Risk; Risk Integration) : _____

Total : _____

Q27 Would you like to receive **Continuing Education Unit (CEU)** credit for this workshop?

○ Yes

○ No

Q28 **General Comments.**
 Please feel free to share any other thoughts about the EVMS Maturity assessment, as well as feedback on the workshop itself in the space below.

 If you would like to modify any previous answers, you can click the left arrow to go back to the previous pages.

_____

_____

Q29
Are you ready to exit? If yes, please click the yes button and the NEXT button (Right Arrow) to complete this workshop and record all your responses. Once you click next, you cannot go back to modify any previous answers. Thank you.

○ Yes

End of Block: Maturity

Appendix C. Sample Maturity Workshop Presentation

Slide 9 — EVMS METR Milestones

EVMS METR Milestones

Date	Milestone
05/08/19	Team kick-off
06/30/20	Developed Maturity and Environment assessments
07/09/20	Maturity Workshop #1
07/16/20	Environment Workshop #1
08/05/20	Maturity Workshop #2
08/12/20	Environment Workshop #2
09/10/20	Environment Workshop #3
09/15/20	Environment Workshop #4
11/05/20	Maturity Workshop #3
11/17/20	**Maturity Workshop #4**
02/15/21	Finish conducting additional workshops to collect data
08/31/21	Finalize research, publications, and software
09/01/21	Start training

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Slide 10 — Typical Large and Complex Projects/Programs

Typical Large and Complex Projects/Programs

- Industrial
- Energy
- Defense
- Aerospace
- Manufacturing
- Infrastructure
- etc.

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Slide 11 — Definitions

Definitions

Earned Value Management (EVM): *The use of performance management information, produced from the EVMS, to plan, direct, and control the execution and accomplishment of contract/project cost, schedule, and technical performance objectives*

Earned Value Management System (EVMS): *An organization's management system for project/program management that integrates a defined set of associated work scopes, schedules and budgets for effective planning, performance, and management control*

EVMS Maturity: *The degree to which an implemented system, associated processes, and deliverables serve as the basis for an effective and compliant EVMS*

EVMS Environment: *The conditions (i.e., people, culture, practices, and resources) that enable or limit the ability to manage the project/program using the EVMS, serving as a basis for timely and effective decision-making.*

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Slide 12

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Slide 13 — Ten EVMS Processes
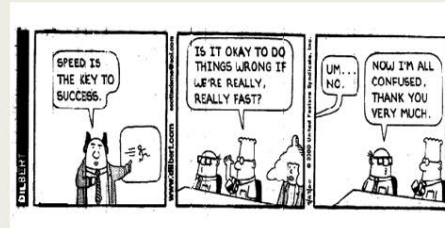
Ten EVMS Processes

- EVMS Maturity Attributes can have a significant impact on the efficacy of the EVMS
- The team identified 56 attributes making up the 10 EVMS processes
- Each attribute can be assessed a maturity level from 1 to 5, with 5 being highest maturity
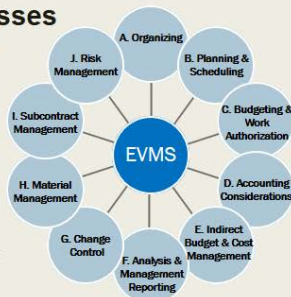
EVMS Process: *A series of interrelated tasks that, together, transform inputs into a system to achieve Earned Value Management (EVM)*

EVMS processes: A. Organizing, B. Planning & Scheduling, C. Budgeting & Work Authorization, D. Accounting Considerations, E. Indirect Budget & Cost Management, F. Analysis & Management Reporting, G. Change Control, H. Material Management, I. Subcontract Management, J. Risk Management

Arizona State University

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Slide 14
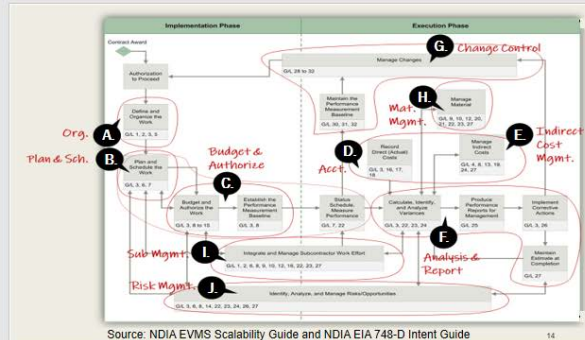
Source: NDIA EVMS Scalability Guide and NDIA EIA 748-D Intent Guide

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Slide 15 — List of 56 EVMS Maturity Attributes

List of 56 EVMS Maturity Attributes

A. ORGANIZING
A.1. Product-Oriented Work Breakdown Structure (WBS)
A.2. Work Breakdown Structure (WBS) Hierarchy
A.3. Organizational Breakdown Structure (OBS)
A.4. Integrated System with Common Structures
A.5. Control Account (CA) to Organizational Element

B. PLANNING AND SCHEDULING
B.1. Authorized, Time-Phased Work Scope
B.2. Schedule Provides Current Status
B.3. Horizontal Integration
B.4. Vertical Integration
B.5. Integrated Master Schedule (IMS) Resources
B.6. Schedule Detail
B.7. Critical Path and Float
B.8. Schedule Margin (SM)
B.9. Progress Measures and Indicators
B.10. Time-Phased Performance Measurement Baseline (PMB)

C. BUDGETING AND WORK AUTHORIZATION
C.1. Scope, Schedule and Budget Alignment
C.2. Summary Level Planning Packages (SLPPs)
C.3. Work Authorization Documents (WADs)
C.4. Work Authorization Prior to Performance
C.5. Budgeting by Elements of Cost (EOC)
C.6. Work Package Planning, Distinguishability, and Duration
C.7. Measurable Units and Budget Substantiation
C.8. Appropriate Assignment of Earned Value Techniques (EVTs)
C.9. Identify and Control Level of Effort (LOE) Work Scope
C.10. Identify Management Reserve (MR) Budget
C.11. Undistributed Budget (UB)
C.12. Reconcile to Target Cost Goal

D. ACCOUNTING CONSIDERATIONS
D.1. Direct Costs
D.2. Actual Cost Reconciliation
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)
D.4. Direct Cost Breakdown Summary

E. INDIRECT BUDGET AND COST MANAGEMENT
E.1. Indirect Account Organization Structure
E.2. Indirect Budget Management
E.3. Record/Allocate Indirect Costs
E.4. Indirect Variance Analysis

F. ANALYSIS AND MANAGEMENT REPORTING
F.1. Calculating Variances
F.2. Variances to Control Accounts (CAs)
F.3. Performance Measurement Information
F.4. Management Analysis and Corrective Actions
F.5. Estimates at Completion (EAC)

G. CHANGE CONTROL
G.1. Controlling Management Reserve (MR) and Undistributed Budget (UB)
G.2. Incorporate Customer Directed Changes in a Timely Manner
G.3. Baseline Changes Reconciliation
G.4. Control of Retroactive Changes
G.5. Preventing Unauthorized Revisions to the Contract Budget Base (CBB)
G.6. Over-Target Baseline (OTB) Authorization

H. MATERIAL MANAGEMENT
H.1. Recording Actual Material Costs
H.2. Material Performance
H.3. Residual Material
H.4. Material Price/Usage Variance
H.5. Identification of Unit Costs and Lot Costs

I. SUBCONTRACT MANAGEMENT
I.1. Subcontract Identification and Requirements Flow Down
I.2. Subcontractor Integration and Analysis
I.3. Subcontract Oversight

J. RISK MANAGEMENT
J.1. Identify, Analyze and Manage Risk
J.2. Risk Integration

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Slide 16 — List of 56 EVMS Maturity Attributes

List of 56 EVMS Maturity Attributes

A. ORGANIZING
A.1. Product-Oriented Work Breakdown Structure (WBS)
A.2. Work Breakdown Structure (WBS) Hierarchy
A.3. Organizational Breakdown Structure (OBS)
A.4. Integrated System with Common Structures
A.5. Control Account (CA) to Organizational Element

B. PLANNING AND SCHEDULING
B.1. Authorized, Time-Phased Work Scope
B.2. Schedule Provides Current Status
B.3. Horizontal Integration
B.4. Vertical Integration
B.5. Integrated Master Schedule (IMS) Resources
B.6. Schedule Detail
B.7. Critical Path and Float
B.8. Schedule Margin (SM)
B.9. Progress Measures and Indicators
B.10. Time-Phased Performance Measurement Baseline (PMB)

C. BUDGETING AND WORK AUTHORIZATION
C.1. Scope, Schedule and Budget Alignment
C.2. Summary Level Planning Packages (SLPPs)
C.3. Work Authorization Documents (WADs)
C.4. Work Authorization Prior to Performance
C.5. Budgeting by Elements of Cost (EOC)
C.6. Work Package Planning, Distinguishability, and Duration
C.7. Measurable Units and Budget Substantiation
C.8. Appropriate Assignment of Earned Value Techniques (EVTs)
C.9. Identify and Control Level of Effort (LOE) Work Scope
C.10. Identify Management Reserve (MR) Budget
C.11. Undistributed Budget (UB)
C.12. Reconcile to Target Cost Goal

D. ACCOUNTING CONSIDERATIONS
D.1. Direct Costs
D.2. Actual Cost Reconciliation
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)
D.4. Direct Cost Breakdown Summary

E. INDIRECT BUDGET AND COST MANAGEMENT
E.1. Indirect Account Organization Structure
E.2. Indirect Budget Management
E.3. Record/Allocate Indirect Costs
E.4. Indirect Variance Analysis

F. ANALYSIS AND MANAGEMENT REPORTING
F.1. Calculating Variances
F.2. Variances to Control Accounts (CAs)
F.3. Performance Measurement Information
F.4. Management Analysis and Corrective Actions
F.5. Estimates at Completion (EAC)

G. CHANGE CONTROL
G.1. Controlling Management Reserve (MR) and Undistributed Budget (UB)
G.2. Incorporate Customer Directed Changes in a Timely Manner
G.3. Baseline Changes Reconciliation
G.4. Control of Retroactive Changes
G.5. Preventing Unauthorized Revisions to the Contract Budget Base (CBB)
G.6. Over-Target Baseline (OTB) Authorization

H. MATERIAL MANAGEMENT
H.1. Recording Actual Material Costs
H.2. Material Performance
H.3. Residual Material
H.4. Material Price/Usage Variance
H.5. Identification of Unit Costs and Lot Costs

I. SUBCONTRACT MANAGEMENT
I.1. Subcontract Identification and Requirements Flow Down
I.2. Subcontractor Integration and Analysis
I.3. Subcontract Oversight

J. RISK MANAGEMENT
J.1. Identify, Analyze and Manage Risk
J.2. Risk Integration

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Maturity Attribute Example

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Maturity Attribute Example

Maturity Attribute Example

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Maturity Attribute Example

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We need your help to:

- **Critique** 25 of the 56 EVMS maturity attributes together, and the remaining 31 afterwards if possible
- Develop credible **weights** for the EVMS maturity attributes and processes

Hence, the purpose of this workshop

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Let's get to work!

- Click on https://tinyURL.com/evmsMaturity

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Background Information

Overview:
The Earned Value Management System (EVMS) Maturity and Environment Total Rating (METR) is an assessment mechanism being developed as part of a DOE-sponsored Joint Research Study led by the Arizona State University (ASU) and representing 15+ government and industry organizations. The envisioned tool will assess a spectrum of EVMS maturity and environment issues centered around the 32 EIA-748 EVMS Guidelines.

The purpose of this workshop is to review and provide feedback on the Maturity assessment section of the draft EVMS METR tool.

Confidentiality Statement:
All data provided to ASU in support of this research activity will be considered confidential information. Individual organization data will not be communicated in any form to any party other than the ASU authorized academic researchers. Any data or analyses that are shared with others or published will represent summaries of data from multiple participating organizations that have been aggregated in a way that will preclude identification of proprietary data. If you have any questions, please contact Dr. G. Edward Gibson, Jr. (egibson4@asu.edu) or Dr. Mounir El Asmar (asmar@asu.edu).

Please note that when you answer questions, you must also click on the **NEXT button (Right Arrow)** to move to the following screen.

Name: Vartenie Aramali

Q1. Please indicate your employer type:
- Government contractor
- Government
- Consultant
- Manufacturer/Constructor
- Other (software developer, World Bank, non-profit organization, etc.); please specify

Academia

If you choose other, please specify.

When you finish, please click next!

Background Information

Q2. Please provide your typical employment role:
- Project controls management
- Project/program management
- Compliance management
- Executive or senior management
- Consulting
- Finance
- Engineering & systems engineering
- Other (contracting, control accounts management or other); please specify

Q3. How many years of Earned Value Management (EVM) experience do you have in total?
- < 5 years
- 5 to 10 years
- 11 to 15 years
- 16 to 20 years
- 21 to 25 years
- > 25 years

Project/Program EVMS Anchor

Q4.
Think of a current or past EVMS application on a project/program that you are or were involved with. You will use this application as your anchor.

Please provide the name of the project/program (e.g., WBS Enterprise): ASU CAVC

What is the approximate project/program total cost? ($ value, e.g. $60M): 60,000,000

What is the approximate date for the start of planning? (Month and Year): 12/2011

What is the approximate date for the end of execution? (Month and Year): 07/2014

Q5. Was the information provided in Q4 a Project or a Program?
- Project
- Program

Please input any amount in dollar value. (e.g., $60 M, 60 M, $60,000,000, or $60 Million)

Please input any type of date format (e.g., 12/2011, Dec. 2011, or December 2011)

Stop here.

Q6. *Process E. Indirect Budget and Cost Management.*
Please provide your *actionable comments or suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under E.2 level 3"; or "I do not agree with the third paragraph under E.3 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

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EVMS Maturity Tool Evaluation/Input

Specific instructions for this exercise are as follows:
1. First, collectively participants will **review** each attribute table with the researchers (each table will be projected on Zoom in order).
2. Participants can ask questions and provide comments and suggestions on each of the 25 attributes in order. Participants should use the Qualtrics **comment** box for each process to provide edits/suggestions/input to any of the attributes.
3. Once all tables within a process have been reviewed (e.g., A1, A2, A3, A4, A5), participants will be asked to **weight** these attributes relative to one another. When weighting, think about your ongoing or recent project/program (the anchor you provided) and allocate percentages to each attribute based on your perception of their relative impact on the maturity of that specific process (e.g., A. Organizing).

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Handling Attributes that are not applicable for <u>your</u> project or program

- All 56 attributes are applicable to EVMS
- However, if it is <u>truly</u> "**Not Applicable**" to the specific project/program you chose for this workshop
- Two responses needed:
  - Identify attribute as not applicable in your comments (e.g., "H.5 Identification of Unit Costs and Lot Costs is not applicable")
  - Provide relative weight as "0" for the attribute

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Example: A.1. Product-Oriented WBS

Example: A.1. Product-Oriented WBS

Slide 33

Review Attributes and Provide Feedback

Q18. **Process A. Organizing.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under A.2 level 3"; or "I do not agree with the third paragraph under A.4 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

A.1 Title: Typo – BWS should say WBS in line
Items to include (bullet list): singular WBS, not multiple!
Level 5 (L5) Bolded Section: should be WBS, not OBS

Slide 34

Review Attributes and Provide Feedback

Q18. **Process A. Organizing.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under A.2 level 3"; or "I do not agree with the third paragraph under A.4 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

A.1 Title: Typo – BWS should say WBS in line
Items to include (bullet list): singular WBS, not multiple!
Level 5 (L5) Bolded Section: should be WBS, not OBS

Slide 35

Review Attributes and Provide Feedback

Q18. **Process A. Organizing.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under A.2 level 3"; or "I do not agree with the third paragraph under A.4 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

A.1 Title: Typo – BWS should say WBS in line
Items to include (bullet list): singular WBS, not multiple!
Level 5 (L5) Bolded Section: should be WBS, not OBS

Slide 36

Review Attributes and Provide Feedback

Q18. **Process A. Organizing.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under A.2 level 3"; or "I do not agree with the third paragraph under A.4 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

A.1 Title: Typo – BWS should say WBS in line
Items to include (bullet list): singular WBS, not multiple!
Level 5 (L5) Bolded Section: should be WBS, not OBS
A.2 Nothing. *Hit Enter to input A3 on a new line, and so on.*
A.3 Nothing
A.4 Nothing
A.5 Nothing

Slide 37

Weight Attributes

Q19. This question is focused on the attributes that make up the **Organizing Process** (Process A). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Organizing Process (Process A). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

A.5 Control Account (CA) to Organizational Element
A.4 Integrated System with Common Structures
A.1 Product-Oriented Work Breakdown Structure (WBS)
A.3 Organizational Breakdown Structure (OBS)
A.2 Work Breakdown Structure (WBS) Hierarchy
Total

The order of the Attributes is randomized.

Total should be 100 (Automatically calculated).

Slide 38

Weight Attributes

Q19. This question is focused on the attributes that make up the **Organizing Process** (Process A). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Organizing Process (Process A). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

A.5 Control Account (CA) to Organizational Element — 20
A.4 Integrated System with Common Structures — 20
A.1 Product-Oriented Work Breakdown Structure (WBS) — 20
A.3 Organizational Breakdown Structure (OBS) — 20
A.2 Work Breakdown Structure (WBS) Hierarchy — 20
Total — 100

The order of the Attributes is randomized.

Total should be 100 (Automatically calculated).

Slide 39

Let's get started with Maturity Attributes!

- We will project the Handout on the screen
- You should be on Question 6

Slide 40

Review Attributes and Provide Feedback

Q6. **Process E. Indirect Budget and Cost Management.**
Please provide your *actionable comments* or *suggested edits* related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under E.2 level 3"; or "I do not agree with the third paragraph under E.3 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

Weight Attributes

Q7. This question is focused on the attributes that make up the **Indirect Budget and Cost Management Process** (Process E). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Indirect Budget and Cost Management Process (Process E). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

E.4 Indirect Variance Analysis	0
E.1 Indirect Account Organization Structure	0
E.3 Record/Allocate Indirect Costs	0
E.2 Indirect Budget Management	0
Total	0

<<   >>

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Review Attributes and Provide Feedback

Q8. **Process F. Analysis and Management Reporting.**
Please provide your actionable comments or suggested edits related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under F.1 level 2", or "I do not agree with the third paragraph under F.3 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

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Weight Attributes

Q9. This question is focused on the attributes that make up the **Analysis and Management Reporting Process** (Process F). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Analysis and Management Reporting Process (Process F). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

F.2 Variances to Control Accounts (CAs)	0
F.1 Calculating Variances	0
F.4 Management Analysis and Corrective Actions	0
F.3 Performance Measurement Information	0
F.5 Estimates at Completion (EAC)	0
Total	0

<<   >>

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Review Attributes and Provide Feedback

Q10. **Process G. Change Control.**
Please provide your actionable comments or suggested edits related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under G.2 level 4", or "I do not agree with the third paragraph under G.6 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

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Weight Attributes

Q11. This question is focused on the attributes that make up the **Change Control Process** (Process G). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Change Control Process (Process G). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

G.6 Over-Target Baseline (OTB) Authorization	0
G.2 Incorporate Customer Directed Changes in a Timely Manner	0
G.1 Controlling Management Reserve (MR) and Undistributed Budget (UB)	0
G.5 Preventing Unauthorized Revisions to the Contract Budget Base (CBB)	0
G.3 Baseline Changes Reconciliation	0
G.4 Control of Retroactive Changes	0
Total	0

<<   >>

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Break

15-minute break

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Let's continue with Maturity Attributes!

- We will project the Handout on the screen

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Review Attributes and Provide Feedback

Q12. **Process H. Material Management.**
Please provide your actionable comments or suggested edits related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "typo in line 1 under H.3 level 3", or "I do not agree with the third paragraph under H.5 Level 4 because this is not typically required for a compliant system"). *Note that you do not have to have comments for every attribute.*

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Weight Attributes (Slide 49)

Q13. This question is focused on the attributes that make up the **Material Management Process** (Process H). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Material Management Process (Process H). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

Attribute	Points
H.3 Residual Material	0
H.2 Material Performance	0
H.1 Recording Actual Material Costs	0
H.5 Identification of Unit Costs and Lot Costs	0
H.4 Material Price/Usage Variance	0
Total	0

Review Attributes and Provide Feedback (Slide 50)

Q14. **Process I. Subcontract Management.**
Please provide your actionable comments or suggested edits related to any attributes that make up this process. Make sure to specify the attribute number, maturity level, and exact location of your comment (e.g., "Typo in line 1 under I.1 description"; or "I do not agree with the third paragraph under I.3 Level 4 because this is not typically required for a compliant system"). Note that you do not have to have comments for every attribute.

Weight Attributes (Slide 51)

Q15. This question is focused on the attributes that make up the **Subcontract Management Process** (Process I). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Subcontract Management Process (Process I). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

Attribute	Points
I.2 Subcontractor Integration and Analysis	0
I.3 Subcontract Oversight	0
I.1 Subcontract Identification and Requirements Flow Down	0
Total	0

Review Attributes and Provide Feedback (Slide 52)

Q16. **Process J. Risk Management.**
Please provide your actionable comments or suggested edits related to any attributes that make up this process. Make sure to specify the process number, maturity level, and exact location of your comment (e.g., "Typo in line 1 under J.1 level 2"; or "I do not agree with the third paragraph under J.2 Level 4 because this is not typically required for a compliant system"). Note that you do not have to have comments for every attribute.

Weight Attributes (Slide 53)

Q17. This question is focused on the attributes that make up the **Risk Management Process** (Process J). Please allocate 100 points divided among the attributes below, based on each attribute's relative impact on the maturity of the Risk Management Process (Process J). When weighting, think about your anchor project/program and allocate percentages accordingly. The total number of points should sum up to 100.

Attribute	Points
J.2 Risk Integration	0
J.1 Identify, Analyze and Manage Risk	0
Total	0

Thank you (Slide 54)

- This is as far as we will go together with the attributes and weighting
- Training is complete ☺
- For Processes A to D, we ask that you finish these outside of this meeting, if possible
- Next we will move forward to Question #26

Weight Processes (Slide 55)

Q28. This question is focused on the relative importance of the ten processes that typically make up an EVMS. Please allocate 100 points divided among these processes based on the relative impact of each process as related to overall EVMS maturity. When weighting, think about your anchor project/program and allocate percentages accordingly. Allocating more points to a process reflects a higher impact on EVMS Maturity. The total number of points should sum up to 100.

An **EVMS Process** is defined as a series of interrelated tasks that, together, transform inputs into a system to achieve Earned Value Management (EVM). The following ten core processes collectively make up an EVMS.

A. Organizing Process (WBS; WBS Hierarchy; OBS; Integrated System; CA to Organizational Element)

C. Budgeting and Work Authorization Process (Alignment of Scope, Schedule, Budget, SLPPs; WADs; Budgeting by EOC; WP; Units and Budget Substantiation; EVTs; LOE; Identify MR, UB; Reconcile Target Cost Goal)

J. Risk Management Process (Identify, Analyze, and Manage Risk; Risk Integration)

B. Planning and Scheduling Process (Time-Phased Work Scope; Schedule; Horizontal and Vertical Integration; IMS Resources; Schedule Detail; CP and Float; SM; Progress Measures; PMB)

F. Analysis and Management Reporting Process (Calculating Variances; Variances to CAs; Performance Measurement Information; Management Analysis and Corrective Actions; EAC)

G. Change Control Process (Control MR and UB; Incorporate Customer Directed Changes; Baseline Changes Reconciliation; Control Retroactive Changes; Unauthorized Revisions to CBB)

E. Indirect Budget and Cost Management Process (Indirect Account; Indirect Budget and Cost; Indirect Variance Analysis)

H. Material Management Process (Recording Actual Material Costs; Material Performance; Residual; Price/Usage Variance; Unit Costs and Lot Costs)

I. Subcontract Management Process (Identification and Requirements Flow Down; Integration and Analysis; Oversight)

D. Accounting Considerations Process (Direct Costs; Actual Cost Reconciliation; WPs; Direct Cost Breakdown Summary)

Total

The order of the processes is randomized.

List of 56 EVMS Maturity Attributes (Slide 56)

A. ORGANIZING
A.1. Product-Oriented Work Breakdown Structure (WBS)
A.2. Work Breakdown Structure (WBS) Hierarchy
A.3. Organizational Breakdown Structure (OBS)
A.4. Integrated System with Common Structures
A.5. Control Account (CA) to Organizational Element

B. PLANNING AND SCHEDULING
B.1. Authorized, Time-Phased Work Scope
B.2. Schedule Provides Current Status
B.3. Horizontal Integration
B.4. Vertical Integration
B.5. Integrated Master Schedule (IMS) Resources
B.6. Schedule Detail
B.7. Critical Path and Float
B.8. Schedule Margin (SM)
B.9. Progress Measures and Indicators
B.10. Time-Phased Performance Measurement Baseline (PMB)

C. BUDGETING AND WORK AUTHORIZATION
C.1. Scope, Schedule and Budget Alignment
C.2. Summary Level Planning Packages (SLPPs)
C.3. Work Authorization Documents (WADs)
C.4. Work Authorization Prior to Performance
C.5. Budgeting by Elements of Cost (EOC)
C.6. Work Package Planning, Distinguishability, and Duration
C.7. Measurable Units and Budget Substantiation
C.8. Appropriate Assignment of Earned Value Techniques (EVTs)
C.9. Identify and Control Level of Effort (LOE) Work Scope
C.10. Identify Management Reserve (MR) Budget
C.11. Undistributed Budget (UB)
C.12. Reconcile to Target Cost Goal

D. ACCOUNTING CONSIDERATIONS
D.1. Direct Costs
D.2. Actual Cost Reconciliation
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)
D.4. Direct Cost Breakdown Summary

E. INDIRECT BUDGET AND COST MANAGEMENT
E.1. Indirect Account Organization Structure
E.2. Indirect Budget Management
E.3. Record/Allocate Indirect Costs
E.4. Indirect Variance Analysis

F. ANALYSIS AND MANAGEMENT REPORTING
F.1. Calculating Variances
F.2. Variances to Control Accounts (CAs)
F.3. Performance Measurement Information
F.4. Management Analysis and Corrective Actions
F.5. Estimates at Completion (EAC)

G. CHANGE CONTROL
G.1. Controlling Management Reserve (MR) and Undistributed Budget (UB)
G.2. Incorporate Customer Directed Changes in a Timely Manner
G.3. Baseline Changes Reconciliation
G.4. Control of Retroactive Changes
G.5. Preventing Unauthorized Revisions to the Contract Budget Base (CBB)
G.6. Over-Target Baseline (OTB) Authorization

H. MATERIAL MANAGEMENT
H.1. Recording Actual Material Costs
H.2. Material Performance
H.3. Residual Material
H.4. Material Price/Usage Variance
H.5. Identification of Unit Costs and Lot Costs

I. SUBCONTRACT MANAGEMENT
I.1. Subcontract Identification and Requirements Flow Down
I.2. Subcontractor Integration and Analysis
I.3. Subcontract Oversight

J. RISK MANAGEMENT
J.1. Identify, Analyze and Manage Risk
J.2. Risk Integration

Weight Processes

Q26. This question is focused on the relative importance of the ten processes that typically make up an EVMS. Please allocate 100 points divided among these processes based on the relative impact of each process as related to overall EVMS maturity. When weighting, think about your anchor project/program and allocate percentages accordingly. Allocating more points to a process reflects a higher impact on EVMS Maturity. The total number of points should sum up to 100.

An EVMS Process is defined as a series of interrelated tasks that, together, transform inputs into a system to achieve Earnest Value Management (EVM). The following ten core processes collectively make up an EVMS.

A. Organizing Process (WBS; WBS Hierarchy; OBS; Integrated System; CA to Organizational Element)

C. Budgeting and Work Authorization Process (Alignment of Scope; Schedule; Budget; SLPPs; WADs; Budgeting by EOC; WP; Units and Budget Substantiation; EVTs; LOE; Identify MR, UB; Reconcile Target Cost Goal)

J. Risk Management Process (Identify, Analyze, and Manage Risk; Risk Integration)

Process	Points
A. Organizing	15
C. Budgeting and Work Authorization	15
J. Risk Management	15
B. Planning and Scheduling Process (Time-Phased Work Scope; Schedule; Horizontal and Vertical Integration; IMS Resources; Schedule Detail; CP and float; SM; Progress Measures; PMB)	10
F. Analysis and Management Reporting Process (Calculating Variances; Variances to CAs; Performance Measurement Information; Management Analysis and Corrective Actions; EAC)	5
G. Change Control Process (Control MR and UB; Incorporate Customer Directed Changes; Baseline Changes Reconciliation; Control Retroactive Changes; Unauthorized Revisions to CBB)	5
E. Indirect Budget and Cost Management Process (Indirect Account; Indirect Budget and Cost; Indirect Variance Analysis)	15
H. Material Management Process (Recording Actual Material Costs; Material Performance; Residual Price/Usage Variance; Unit Costs and Lot Costs)	5
I. Subcontract Management Process (Identification and Requirements Flow Down; Integration and Analysis; Oversight)	5
D. Accounting Considerations Process (Direct Costs; Actual Cost Reconciliation; WPs; Direct Cost Breakdown Summary)	10
Total	100

The order of the processes is randomized.

List of 56 EVMS Maturity Attributes

A. ORGANIZING
A.1. Product-Oriented Work Breakdown Structure (WBS)
A.2. Work Breakdown Structure (WBS) Hierarchy
A.3. Organizational Breakdown Structure (OBS)
A.4. Integrated System with Common Structures
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B.8. Schedule Margin (SM)
B.9. Progress Measures and Indicators
B.10. Time-Phased Performance Measurement Baseline (PMB)

C. BUDGETING AND WORK AUTHORIZATION
C.1. Scope, Schedule and Budget Alignment
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C.10. Identify Management Reserve (MR) Budget
C.11. Undistributed Budget (UB)
C.12. Reconcile to Target Cost Goal

D. ACCOUNTING CONSIDERATIONS
D.1. Direct Costs
D.2. Actual Cost Reconciliation
D.3. Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)
D.4. Direct Cost Breakdown Summary

E. INDIRECT BUDGET AND COST MANAGEMENT
E.1. Indirect Account Organization Structure
E.2. Indirect Budget Management
E.3. Record/Allocate Indirect Costs
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F. ANALYSIS AND MANAGEMENT REPORTING
F.1. Calculating Variances
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H.1. Recording Actual Material Costs
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I.1. Subcontractor Identification and Requirements Flow Down
I.2. Subcontractor Integration and Analysis
I.3. Subcontractor Oversight

J. RISK MANAGEMENT
J.1. Identify, Analyze and Manage Risk
J.2. Risk Integration

Continuing Education Unit (CEU) Credit

Q27. Would you like to receive **Continuing Education Unit (CEU)** credit for this workshop?

- ● Yes
- ○ No

General Comments.

Q28. **General Comments.**
Please feel free to share any other thoughts about the EVMS Maturity assessment, as well as feedback on the workshop itself in the space below.

If you would like to modify any previous answers, you can click the left arrow to go back to the previous pages.

Amnesty

"Automation" requirement for Level 5 is too aggressive.
Consider applicability for different types of project/program
Good fit with 748.
Good value for our organization! Especially to self-rate.
The workshop was a little too long; Would have liked more discussion time.
Looking forward to the final product.

Exit Confirmation

Q29.
Are you ready to exit? If yes, please click the yes button and the NEXT button (Right Arrow) to complete this workshop and record all your responses. Once you click next, you cannot go back to modify any previous answers. Thank you.

- ● Yes

Please click on NEXT button (Right Arrow) to record your responses. If you click here, you will not be able to modify any previous answers.

Completion Screen

If you see this screen, your response is successfully saved in our database.

Survey Completion
0% ——————————— 100%

EVMS METR: Maturity Development Workshop

We thank you for your time spent taking this survey.
Your response has been recorded.

Conclusions & Wrap-up

- What we did today
  - *Reviewed the EVMS Maturity attributes*
  - *Weighted the attributes and the processes*
- Thank you for your input!
- CEUs will be emailed to you
- We will send you published documents when they become available

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EVMS Maturity Rating Score Sheet Example

PROCESS H – MATERIAL MANAGEMENT

Attribute	N/A	1	2	3	4	5	Comments
H.1. Recording Actual Material Costs							
H.2. Material Performance							
H.3. Residual Material							
H.4. Material Price/Usage Variance							
H.5. Identification of Unit Costs and Lot Costs							
Process H – Material Management, Column Frequency Totals							

(Maturity Level columns: N/A, 1, 2, 3, 4, 5)

Maturity Levels
N/A= Not Applicable
1 = Not Yet Started
2 = Major Gaps
3 = Minor Gaps
4 = No Gaps
5 = Best in Class

EVMS Maturity Rating Score Sheet Example

PROCESS H – MATERIAL MANAGEMENT							
		Maturity Level					
Attribute	N/A	1	2	3	4	5	Comments
H.1. Recording Actual Material Costs					X		
H.2. Material Performance						X	
H.3. Residual Material		X					We have not started working on this process
H.4. Material Price/Usage Variance					X		
H.5. Identification of Unit Costs and Lot Costs	X						Unit costs are not applicable to this program
Process H – Material Management, Column Frequency Totals	1	1	0	0	2	1	

Maturity Levels

N/A= Not Applicable 2 = Major Gaps 4 = No Gaps
1 = Not Yet Started 3 = Minor Gaps 5 = Best in Class

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EVMS Environment Rating Score Sheet Example

1. Culture
Culture is, by definition, the display of behaviors. Organizational culture is a system of common assumptions, values and beliefs (or the lack thereof), which governs how people behave in organizations. Organizational values and beliefs should align with the development and outcomes of a successful EVMS. The project/program culture can enable or hinder the effectiveness of the EVMS.

Factors for Review	Not Acceptable	Needs Improvement	Meets Some	Meets Most	High Performing
1a. The **contractor organization is supportive and committed** to EVMS implementation, including making the necessary investments for regular maintenance and self-governance.					X
1b. The **customer organization is supportive and committed** to the implementation of EVMS.					X
1c. The project/program **culture fosters trust, honesty, transparency, communication, and shared values** across functions.				X	
1d. **Effective teamwork exists** and synergistic team members are working toward a common goal.			X		
1e. The project/program **leadership effectively manages change** using EVMS, including corrective actions and continuous improvement.				X	
1f. **Alignment and cohesion exist among key team members** who implement and execute EVMS, including common objectives and priorities.				X	
1g. Project/program leaders make **timely and transparent decisions** informed by the EVMS.			X		
Column Totals (For Culture)*	0	0	2	3	2

*frequency number in column

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Envisioned EVMS Rating Plot

EVMS Maturity and Environment Matrix

High Maturity Poor Environment

High Maturity Good Environment

Low Maturity Poor Environment

Low Maturity Good Environment
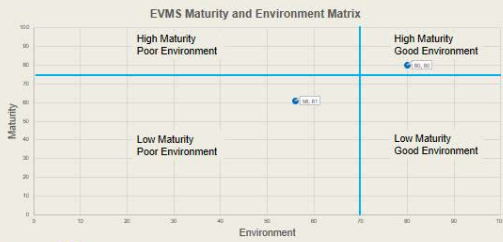
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Questions/Comments/Discussion

THANK YOU!

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Appendix D. List of Maturity Attributes

A. ORGANIZING
A.1.　Product-Oriented Work Breakdown Structure (WBS)
A.2.　Work Breakdown Structure (WBS) Hierarchy
A.3.　Organizational Breakdown Structure (OBS)
A.4.　Integrated System with Common Structures
A.5.　Control Account (CA) to Organizational Element

B. PLANNING AND SCHEDULING
B.1.　Authorized, Time-Phased Work Scope
B.2.　Schedule Provides Current Status
B.3.　Horizontal Integration
B.4.　Vertical Integration
B.5.　Integrated Master Schedule (IMS) Resources
B.6.　Schedule Detail
B.7.　Critical Path and Float
B.8.　Schedule Margin (SM)
B.9.　Progress Measures and Indicators
B.10.　Time-Phased Performance Measurement Baseline (PMB)

C. BUDGETING AND WORK AUTHORIZATION
C.1.　Scope, Schedule and Budget Alignment
C.2.　Summary Level Planning Packages (SLPPs)
C.3.　Work Authorization Documents (WADs)
C.4.　Work Authorization Prior to Performance
C.5.　Budgeting by Elements of Cost (EOC)
C.6.　Work Package Planning, Distinguishability, and Duration
C.7.　Measurable Units and Budget Substantiation
C.8.　Appropriate Assignment of Earned Value Techniques (EVTs)
C.9.　Identify and Control Level of Effort (LOE) Work Scope
C.10.　Identify Management Reserve (MR) Budget
C.11.　Undistributed Budget (UB)
C.12.　Reconcile to Target Cost Goal

D. ACCOUNTING CONSIDERATIONS
D.1.　Direct Costs
D.2.　Actual Cost Reconciliation
D.3.　Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)
D.4.　Direct Cost Breakdown Summary

E. INDIRECT BUDGET AND COST MANAGEMENT
E.1.　Indirect Account Organization Structure
E.2.　Indirect Budget Management
E.3.　Record/Allocate Indirect Costs
E.4.　Indirect Variance Analysis

F. ANALYSIS AND MANAGEMENT REPORTING
F.1.　Calculating Variances
F.2.　Variances to Control Accounts (CAs)
F.3.　Performance Measurement Information
F.4.　Management Analysis and Corrective Actions
F.5.　Estimates at Completion (EAC)

G. CHANGE CONTROL
G.1.　Controlling Management Reserve (MR) and Undistributed Budget (UB)
G.2.　Incorporate Customer Directed Changes in a Timely Manner
G.3.　Baseline Changes Reconciliation
G.4.　Control of Retroactive Changes
G.5.　Preventing Unauthorized Revisions to the Contract Budget Base (CBB)
G.6.　Over-Target Baseline (OTB) Authorization

H. MATERIAL MANAGEMENT
H.1.　Recording Actual Material Costs
H.2.　Material Performance
H.3.　Residual Material
H.4.　Material Price/Usage Variance
H.5.　Identification of Unit Costs and Lot Costs

I. SUBCONTRACT MANAGEMENT
I.1.　Subcontract Identification and Requirements Flow Down
I.2.　Subcontractor Integration and Analysis
I.3.　Subcontract Oversight

J. RISK MANAGEMENT
J.1.　Identify, Analyze and Manage Risk
J.2.　Risk Integration

Appendix E. EVMS Maturity Attribute and Sub-process Weighting Results from Workshops (Sample)

Sub-process A - Top Attributes; N=37

Average Weight (%)

Attribute	Weight
A.4 Integrated System with Common Structures	23.9%
A.1 Product-Oriented Work Breakdown Structure (WBS)	22.8%
A.2 Work Breakdown Structure (WBS) Hierarchy	19.9%
A.5 Control Account (CA) to Organizational Element	18.4%
A.3 Organizational Breakdown Structure (OBS)	15.0%

EVMS - Top Sub-processes; N=48

Average Weight (%)

Sub-process	Weight
B. Planning and Scheduling Process	16.6%
F. Analysis and Management Reporting Process	11.9%
C. Budgeting and Work Authorization Process	11.6%
G. Change Control Process	11.4%
A. Organizing Process	10.9%
J. Risk Management Process	9.3%
D. Accounting Considerations Process	8.3%
I. Subcontract Management Process	7.7%
H. Material Management Process	6.3%
E. Indirect Budget and Cost Management Process	6.0%

The remaining data and analyses reside at Arizona State University with the authors.

Appendix F. Descriptive Statistics of EVMS Sub-process Weights (Sample)

Sub-process			Statistic	Std. Error
A	Mean		10.88	.721
	95% Confidence Interval for Mean	Lower Bound	9.42	
		Upper Bound	12.33	
	5% Trimmed Mean		10.49	
	Median		10.00	
	Variance		24.963	
	Std. Deviation		4.996	
	Minimum		4	
	Maximum		30	
	Range		26	
	Interquartile Range		9	
	Skewness		1.202	.343
	Kurtosis		3.250	.674

The remaining data and analyses reside at Arizona State University with the authors.

Appendix G. Workshop EVMS Sub-process Weights – Standard Deviations (Sample)

Notes:
*SD stands for Standard Deviation.
*The red highlighted in this appendix indicates that the sub-process weight is 2.5SD distant from the sub-process mean.

Sub-process A			
Participant	Participant's Weight for this sub-process	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD
MWSP1-1	5	5.88	1.18
MWSP1-2	20	9.13	1.83
MWSP1-3	10	0.88	0.18
MWSP1-4	15	4.13	0.83
MWSP1-5	5	5.88	1.18
MWSP1-6	10	0.88	0.18
MWSP1-7	5	5.88	1.18
MWSP1-8	5	5.88	1.18
MWSP1-9	10	0.88	0.18
MWSP1-10	10	0.88	0.18
MWSP1-11	10	0.88	0.18
MWSP2-1	10	0.88	0.18
MWSP2-2	14	3.13	0.63
MWSP2-3	15	4.13	0.83
MWSP2-4	10	0.88	0.18
MWSP2-5	15	4.13	0.83
MWSP2-6	5	5.88	1.18
MWSP2-7	15	4.13	0.83
MWSP2-8	5	5.88	1.18
MWSP2-9	15	4.13	0.83
MWSP2-10	10	0.88	0.18
MWSP2-12	10	0.88	0.18
MWSP3-1	5	5.88	1.18
MWSP3-2	10	0.88	0.18
MWSP3-3	10	0.88	0.18
MWSP3-4	5	5.88	1.18
MWSP3-5	5	5.88	1.18
MWSP3-6	20	9.13	1.83
MWSP3-7	10	0.88	0.18
MWSP3-8	10	0.88	0.18
MWSP3-9	15	4.13	0.83
MWSP3-10	10	0.88	0.18
MWSP3-11	12	1.13	0.23
MWSP3-12	15	4.13	0.83

Sub-process A			
Participant	Participant's Weight for this sub-process	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD
MWSP3-13	15	4.13	0.83
MWSP4-1	15	4.13	0.83
MWSP4-2	10	0.88	0.18
MWSP4-3	10	0.88	0.18
MWSP4-4	15	4.13	0.83
MWSP4-5	10	0.88	0.18
MWSP4-6	10	0.88	0.18
MWSP4-7	10	0.88	0.18
MWSP4-8	12	1.13	0.23
MWSP4-9	4	6.88	1.38
MWSP4-10	5	5.88	1.18
MWSP4-11	30	19.13	3.83
MWSP4-12	15	4.13	0.83
MWSP4-13	5	5.88	1.18

The remaining data and analyses reside at Arizona State University with the authors.

Appendix H. Descriptive Statistics of Maturity Attribute Weights (Sample)

Descriptive Statistics for Attributes of Sub-process A

Attribute			Statistic	Std. Error
A.1	Mean		23.47	1.591
	95% Confidence Interval for Mean	Lower Bound	20.24	
		Upper Bound	26.70	
	5% Trimmed Mean		22.69	
	Median		20.00	
	Variance		91.171	
	Std. Deviation		9.548	
	Minimum		10	
	Maximum		60	
	Range		50	
	Interquartile Range		9	
	Skewness		1.664	.393
	Kurtosis		5.231	.768
A.2	Mean		19.86	1.044
	95% Confidence Interval for Mean	Lower Bound	17.74	
		Upper Bound	21.98	
	5% Trimmed Mean		20.00	
	Median		20.00	
	Variance		39.266	
	Std. Deviation		6.266	
	Minimum		5	
	Maximum		30	
	Range		25	
	Interquartile Range		9	
	Skewness		-.037	.393
	Kurtosis		-.051	.768
A.3	Mean		14.86	1.203
	95% Confidence Interval for Mean	Lower Bound	12.42	
		Upper Bound	17.30	
	5% Trimmed Mean		14.41	
	Median		15.00	
	Variance		52.123	
	Std. Deviation		7.220	
	Minimum		5	
	Maximum		35	
	Range		30	
	Interquartile Range		10	
	Skewness		.835	.393
	Kurtosis		.828	.768
A.4	Mean		24.03	1.712
	95% Confidence Interval for Mean	Lower Bound	20.55	
		Upper Bound	27.50	
	5% Trimmed Mean		23.64	
	Median		20.00	
	Variance		105.456	
	Std. Deviation		10.269	
	Minimum		5	
	Maximum		50	
	Range		45	
	Interquartile Range		10	
	Skewness		.591	.393
	Kurtosis		.284	.768

Attribute			Statistic	Std. Error
A.5	Mean		17.78	1.099
	95% Confidence Interval for Mean	Lower Bound	15.55	
		Upper Bound	20.01	
	5% Trimmed Mean		17.81	
	Median		20.00	
	Variance		43.492	
	Std. Deviation		6.595	
	Minimum		5	
	Maximum		30	
	Range		25	
	Interquartile Range		5	
	Skewness		-.206	.393
	Kurtosis		-.153	.768

The remaining data and analyses reside at Arizona State University with the authors.

Appendix I. Workshop Maturity Attribute Weights – Standard Deviations (Sample)

Notes:
*SD stands for Standard Deviation.
* The red highlighted in this appendix indicates that the attribute weight is 2.5SD distant from the attribute mean.

Sub-process A, Attributes

Participant	Participant's Weight for attribute A.1	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD	Participant's Weight for attribute A.2	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD
MWSP1-1	20	3.47	0.36	20	0.14	0.02
MWSP1-2	25	1.53	0.16	20	0.14	0.02
MWSP1-3	30	6.53	0.68	30	10.14	1.62
MWSP1-4	15	8.47	0.89	30	10.14	1.62
MWSP1-5	20	3.47	0.36	25	5.14	0.82
MWSP1-6	20	3.47	0.36	20	0.14	0.02
MWSP1-7	15	8.47	0.89	25	5.14	0.82
MWSP1-8	10	13.47	1.41	10	9.86	1.57
MWSP1-9	40	16.53	1.73	20	0.14	0.02
MWSP1-10	10	13.47	1.41	30	10.14	1.62
MWSP1-11	25	1.53	0.16	20	0.14	0.02
MWSP1-12	25	1.53	0.16	25	5.14	0.82
MWSP2-6	20	3.47	0.36	20	0.14	0.02
MWSP2-8	10	13.47	1.41	15	4.86	0.78
MWSP2-9	60	36.53	3.83	20	0.14	0.02
MWSP2-10	20	3.47	0.36	20	0.14	0.02
MWSP2-12	20	3.47	0.36	20	0.14	0.02
MWSP3-1	20	3.47	0.36	15	4.86	0.78
MWSP3-2	20	3.47	0.36	20	0.14	0.02
MWSP3-3	30	6.53	0.68	10	9.86	1.57
MWSP3-4	25	1.53	0.16	15	4.86	0.78
MWSP3-5	20	3.47	0.36	15	4.86	0.78
MWSP3-6	30	6.53	0.68	30	10.14	1.62
MWSP3-7	10	13.47	1.41	30	10.14	1.62
MWSP3-8	20	3.47	0.36	20	0.14	0.02
MWSP3-9	30	6.53	0.68	20	0.14	0.02
MWSP3-10	20	3.47	0.36	15	4.86	0.78
MWSP3-11	25	1.53	0.16	20	0.14	0.02
MWSP3-12	20	3.47	0.36	15	4.86	0.78
MWSP3-13	25	1.53	0.16	15	4.86	0.78
MWSP4-1	25	1.53	0.16	20	0.14	0.02
MWSP4-2	20	3.47	0.36	20	0.14	0.02
MWSP4-5	30	6.53	0.68	30	10.14	1.62
MWSP4-8	20	3.47	0.36	20	0.14	0.02
MWSP4-10	30	6.53	0.68	5	14.86	2.37
MWSP4-12	40	16.53	1.73	10	9.86	1.57

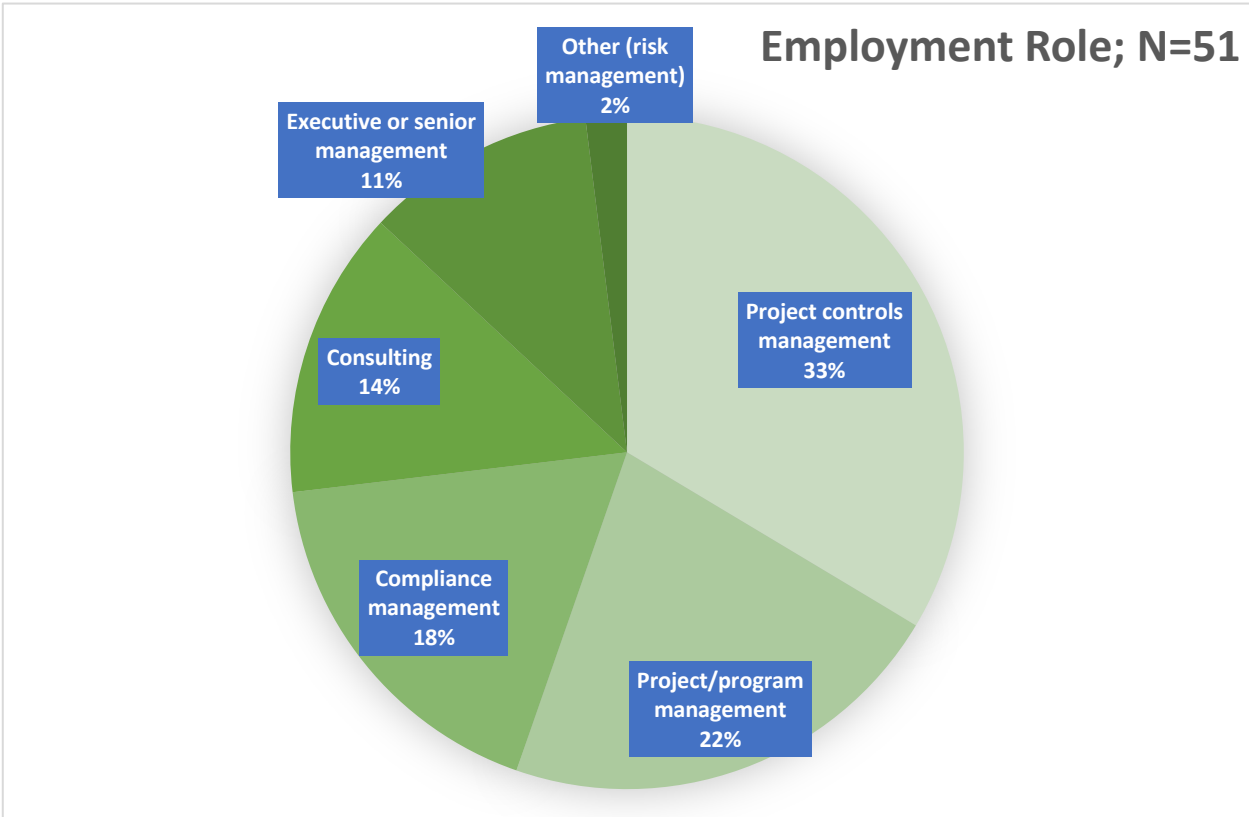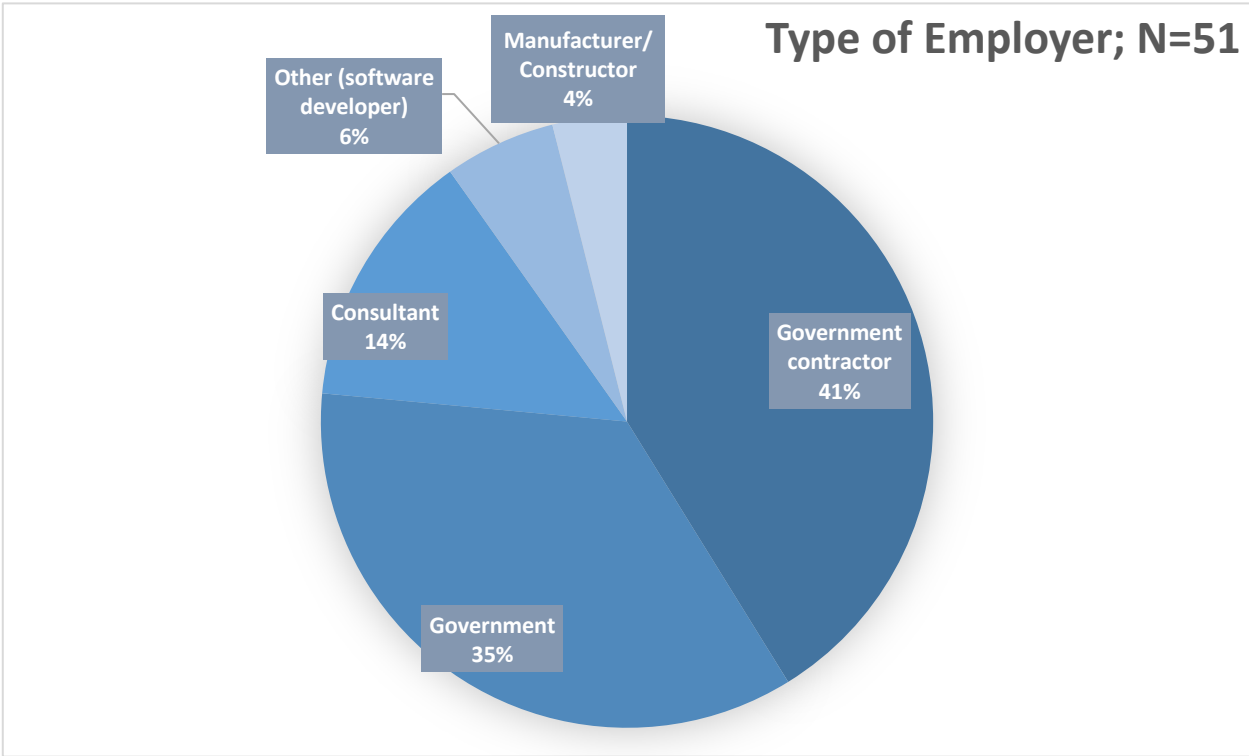| Participant	Participant's Weight for attribute A.3	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD	Participant's Weight for attribute A.4	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD
MWSP1-1	35	20.14	2.79	5	19.03	1.85
MWSP1-2	10	4.86	0.67	30	5.97	0.58
MWSP1-3	20	5.14	0.71	10	14.03	1.37
MWSP1-4	15	0.14	0.02	15	9.03	0.88
MWSP1-5	15	0.14	0.02	25	0.97	0.09
MWSP1-6	20	5.14	0.71	20	4.03	0.39
MWSP1-7	15	0.14	0.02	25	0.97	0.09
MWSP1-8	10	4.86	0.67	50	25.97	2.53
MWSP1-9	10	4.86	0.67	20	4.03	0.39
MWSP1-10	30	15.14	2.10	10	14.03	1.37
MWSP1-11	15	0.14	0.02	20	4.03	0.39
MWSP1-12	10	4.86	0.67	20	4.03	0.39
MWSP2-6	20	5.14	0.71	20	4.03	0.39
MWSP2-8	5	9.86	1.37	40	15.97	1.56
MWSP2-9	5	9.86	1.37	10	14.03	1.37
MWSP2-10	20	5.14	0.71	20	4.03	0.39
MWSP2-12	20	5.14	0.71	20	4.03	0.39
MWSP3-1	5	9.86	1.37	30	5.97	0.58
MWSP3-2	10	4.86	0.67	30	5.97	0.58
MWSP3-3	10	4.86	0.67	20	4.03	0.39
MWSP3-4	15	0.14	0.02	20	4.03	0.39
MWSP3-5	20	5.14	0.71	30	5.97	0.58
MWSP3-6	10	4.86	0.67	25	0.97	0.09
MWSP3-7	15	0.14	0.02	35	10.97	1.07
MWSP3-8	15	0.14	0.02	30	5.97	0.58
MWSP3-9	10	4.86	0.67	20	4.03	0.39
MWSP3-10	15	0.14	0.02	25	0.97	0.09
MWSP3-11	20	5.14	0.71	15	9.03	0.88
MWSP3-12	10	4.86	0.67	40	15.97	1.56
MWSP3-13	5	9.86	1.37	45	20.97	2.04
MWSP4-1	15	0.14	0.02	25	0.97	0.09
MWSP4-2	20	5.14	0.71	20	4.03	0.39
MWSP4-5	10	4.86	0.67	10	14.03	1.37
MWSP4-8	20	5.14	0.71	20	4.03	0.39
MWSP4-10	30	15.14	2.10	25	0.97	0.09
MWSP4-12	5	9.86	1.37	40	15.97	1.56

Participant	Participant's Weight for attribute A.5	Distance of participant's weight from mean	Distance of participant's weight from mean in function of SD
MWSP1-1	20	2.22	0.34
MWSP1-2	15	2.78	0.42
MWSP1-3	10	7.78	1.18
MWSP1-4	25	7.22	1.10
MWSP1-5	15	2.78	0.42
MWSP1-6	20	2.22	0.34
MWSP1-7	20	2.22	0.34
MWSP1-8	20	2.22	0.34
MWSP1-9	10	7.78	1.18
MWSP1-10	20	2.22	0.34
MWSP1-11	20	2.22	0.34
MWSP1-12	20	2.22	0.34
MWSP2-6	20	2.22	0.34
MWSP2-8	30	12.22	1.85
MWSP2-9	5	12.78	1.94
MWSP2-10	20	2.22	0.34
MWSP2-12	20	2.22	0.34
MWSP3-1	30	12.22	1.85
MWSP3-2	20	2.22	0.34
MWSP3-3	30	12.22	1.85
MWSP3-4	25	7.22	1.10
MWSP3-5	15	2.78	0.42
MWSP3-6	5	12.78	1.94
MWSP3-7	10	7.78	1.18
MWSP3-8	15	2.78	0.42
MWSP3-9	20	2.22	0.34
MWSP3-10	25	7.22	1.10
MWSP3-11	20	2.22	0.34
MWSP3-12	15	2.78	0.42
MWSP3-13	10	7.78	1.18
MWSP4-1	15	2.78	0.42
MWSP4-2	20	2.22	0.34
MWSP4-5	20	2.22	0.34
MWSP4-8	20	2.22	0.34
MWSP4-10	10	7.78	1.18
MWSP4-12	5	12.78	1.94

The remaining data and analyses reside at Arizona State University with the authors.

Appendix J. Maturity Workshop Results Excluding Outliers (Sample)

Type of Employer; N=51

- Government contractor 41%
- Government 35%
- Consultant 14%
- Other (software developer) 6%
- Manufacturer/ Constructor 4%

Employment Role; N=51

- Project controls management 33%
- Project/program management 22%
- Compliance management 18%
- Consulting 14%
- Executive or senior management 11%
- Other (risk management) 2%

Years of EVM Experience (19.7 avg); N=51

- > 25 years — 45%
- 16 to 20 years — 20%
- 11 to 15 years — 18%
- 21 to 25 years — 9%
- < 5 years — 4%
- 5 to 10 years — 4%

EVMS - Top Sub-processes; N=43

Average Weight (%)

Sub-process	Average Weight (%)
B. Planning and Scheduling Process	15.7%
C. Budgeting and Work Authorization Process	12.2%
F. Analysis and Management Reporting Process	12.0%
G. Change Control Process	11.7%
A. Organizing Process	10.5%
J. Risk Management Process	8.9%
I. Subcontract Management Process	8.0%
D. Accounting Considerations Process	7.9%
H. Material Management Process	6.6%
E. Indirect Budget and Cost Management Process	6.5%

Sub-process A - Top Attributes; N=33

Average Weight (%)

Attribute	Average Weight (%)
A.4 Integrated System with Common Structures	24.1%
A.1 Product-Oriented Work Breakdown Structure (WBS)	22.6%
A.2 Work Breakdown Structure (WBS) Hierarchy	20.0%
A.5 Control Account (CA) to Organizational Element	18.6%
A.3 Organizational Breakdown Structure (OBS)	14.7%

The remaining data and analyses reside at Arizona State University with the authors.

Appendix K. Maturity Normalized Attribute Weighted Scores

Maturity Attribute	Normalized Attribute Weighted Score (Level 5)
A.1 Product-Oriented Work Breakdown Structure (WBS)	23.7
A.2 Work Breakdown Structure (WBS) Hierarchy	21.0
A.3 Organizational Breakdown Structure (OBS)	15.4
A.4 Integrated System with Common Structures	25.3
A.5 Control Account (CA) to Organizational Element	19.6
B.1 Authorized, Time-Phased Work Scope	17.3
B.2 Schedule Provides Current Status	17.3
B.3 Horizontal Integration	15.9
B.4 Vertical Integration	14.7
B.5 Integrated Master Schedule (IMS) Resources	13.4
B.6 Schedule Detail	14.1
B.7 Critical Path and Float	20.8
B.8 Schedule Margin (SM)	7.7
B.9 Progress Measures and Indicators	16.2
B.10 Time-Phased Performance Measurement Baseline (PMB)	19.7
C.1 Scope, Schedule and Budget Alignment	14.9
C.2 Summary Level Planning Packages (SLPPs)	4.2
C.3 Work Authorization Documents (WADs)	11.7
C.4 Work Authorization Prior to Performance	8.7
C.5 Budgeting by Elements of Cost (EOC)	10.9
C.6 Work Package Planning, Distinguishability, and Duration	10.9
C.7 Measurable Units and Budget Substantiation	10.1
C.8 Appropriate Assignment of Earned Value Techniques (EVTs)	13.5
C.9 Identify and Control Level of Effort (LOE) Work Scope	9.1
C.10 Identify Management Reserve (MR) Budget	11.4
C.11 Undistributed Budget (UB)	7.6
C.12 Reconcile to Target Cost Goal	9.1
D.1 Direct Costs	20.8
D.2 Actual Cost Reconciliation	22.3
D.3 Recording Direct Costs to Control Accounts (CAs) and/or Work Packages (WPs)	21.9
D.4 Direct Cost Breakdown Summary	14.1
E.1 Indirect Account Organization Structure	13.9
E.2 Indirect Budget Management	18.7
E.3 Record/Allocate Indirect Costs	16.5
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F.4 Management Analysis and Corrective Actions	28.8

Maturity Attribute	Normalized Attribute Weighted Score (Level 5)
F.5 Estimates at Completion (EAC)	28.6
G.1 Controlling Management Reserve (MR) and Undistributed Budget (UB)	21.4
G.2 Incorporate Customer Directed Changes in a Timely Manner	23.1
G.3 Baseline Changes Reconciliation	20.6
G.4 Control of Retroactive Changes	18.8
G.5 Preventing Unauthorized Revisions to the Contract Budget Base (CBB)/Project Budget Base (PBB)	21.1
G.6 Over-Target Baseline (OTB) Authorization	11.8
H.1 Recording Actual Material Costs	17.1
H.2 Material Performance	16.9
H.3 Residual Material	10.0
H.4 Material Price/Usage Variance	13.2
H.5 Identification of Unit Costs and Lot Costs	8.7
I.1 Subcontract Identification and Requirements Flow Down	25.2
I.2 Subcontractor Integration and Analysis	29.6
I.3 Subcontract Oversight	24.8
J.1 Identify, Analyze and Manage Risk	47.6
J.2 Risk Integration	41.5
SUM=	1000.0

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