State of Michigan (SOM)

Measurement and Analysis Process Manual
Version 1.0

State Unified Information Technology Environment (SUITE)

January 2009

Michigan Department of Information Technology

Preface

This initial development of the *Measurement and Analysis Process Manual* was published in January 2009, and was developed as part of a continuing effort to improve the quality, performance, and productivity of State of Michigan information systems. Development of the *Measurement and Analysis Process Manual* was governed by the Michigan *State Unified Information Technology Environment* (SUITE) initiative.

The purpose of SUITE is to standardize methodologies, procedures, training, and tools for project management and systems development lifecycle management throughout the Michigan Department of Information Technology (MDIT) in order to implement repeatable processes and conduct development activities according to Capability Maturity Model Integrated (CMMI) Level 3 requirements.

A formal enterprise level support structure will be created to support, improve and administer all SUITE components, including the Systems Engineering Methodology (SEM), the Project Management Methodology (PMM), and related enterprise initiatives. Until that structure is in place, questions regarding Measurement and Analysis should be sent to the SUITE Core Team at SUITE@michigan.gov.

Acknowledgements

The State of Michigan would like to thank the following individuals and organizations that made this version of the State of Michigan *Measurement and Analysis Process Manual* possible. Without their input and hard work, this would not have been achieved. In addition to the individuals listed below, members of the SUITE Process Workgroup participated in a structured walkthrough of this document and thereby improved its quality.

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The following information is being used to control and track modifications made to this document

Revision Date	Author	Section(s)	Summary

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Section: **1.0 Overview**

Purpose: Measurement and Analysis (MA) is a Capability Maturity Model Integration (CMMI) Support Process Area (PA) starting with CMMI Maturity Level 2.

The purpose of Measurement and Analysis in general is to develop and sustain a measurement capability that is used to support management information needs (CMMI).

The purpose of the *Measurement and Analysis Process Manual* is to provide guidance on the development and sustainability of measurement capabilities in support of the management information needs of the Michigan Department of Information Technology.

Scope: The measures, metrics and analysis referred to in the *Measurement and Analysis Process Manual* focus on application development and maintenance projects using the SUITE processes, including PMM and SEM and their associated derivatives.

Future versions of this process manual will contain additional measurement categories, including customer satisfaction measures, productivity measures, Systems Engineering Process Group (SEPG) throughput measures, etc.

Organization: This process manual consists of the following sections:

- Overview
- Performance Measures
- Metrics Collection and Storage
- Measurement Analysis and Results
- Bibliography
- Appendices

Background: In general, there are three basic performance measurement types: **1) measures of efforts**; **2) measures of accomplishments**; and **3) measures that relate efforts to accomplishments**.

Measures of Efforts: Efforts are the amount of resources, in terms of funds, people, materials, equipment, etc., applied to a project.

Example: The amount of funds expended and the number of effort hours used on a project.

Measures of Accomplishments: Accomplishments are milestones achieved with the resources expended. There are two types of accomplishments – outputs and outcomes. Outputs relate to the quantity of goods or services produced. Outcomes relate to the results of providing those outputs.

Output example: Number of modules coded; number of modules tested; number of modules inspected.

Outcome example: The payment module of the payroll system completed on schedule; the payment module completed within budget; the payment module was installed with no defects reported in the first 30 days in production.

Measures that relate efforts to accomplishments: These measures are associated with resources or cost relative to accomplishments achieved. They provide information about the production of an output at a given level of resource use and demonstrate an entity's capability when compared with previous results, internally established goals and objectives, generally accepted norms or standards, or results achieved by similar entities.

Example: Amount of funds expended for the portion of project completed versus the amount of funds planned to be expended for the portion of work planned at a set point during the project (e.g. Earned Value); number of configuration items (CIs) created as a result of effort hours expended.

Description: The SUITE Measurement and Analysis process involves specifying the objectives of measurement and analysis such that they are aligned with identified information needs and objectives. The measures, analysis techniques, and mechanism for data collection, data storage, reporting, and feedback are an integral part of the measurement and analysis process.

Implementing the collection, storage, analysis and reporting of the data provides objective results that can be used to make informed decisions and take appropriate corrective actions and/or process improvements. The integration of measurement and analysis activities into the processes of the project provides objective planning and estimating – tracking actual performance against established plans and objectives. It identifies and resolves process related issues, and provides a basis for incorporating metrics into additional processes in the future.

The staff required to implement a measurement capability resides on a project team, work unit, SUITE Support Team, and at the MDIT enterprise level. Measurement capability may be integrated into individual projects or other organizational functions (e.g. quality assurance, project management).

The source of data for measurement activities is at the project level. However, a

measurement capability will be useful for addressing organization- and/or enterprise-wide information needs. To support this enterprise capability, the measurement activities must support information needs at multiple levels including the business, organizational unit, and project to minimize rework as the organization matures.

Project-specific detail data and results are stored in a project-specific repository. As data is stored more widely across projects, summary project data may reside in the organization's measurement repository.

Measurement and analysis of product components provided by MDIT's contractors is also essential for effective management. It is possible, with careful project management of contractor agreements, to provide insight into the data that support contractor performance analysis.

Measurement data is captured on an MDIT form titled *Project Metrics Collection* (SEM-0188). The SEM-0188 is to be completed by the MDIT project manager within 45 days after the system has been transitioned to the production environment. The SEM-0188 can be found in the MDIT forms index. A copy of the SEM-0188 can be found in Appendix B of this manual.

Section: **2.0 Performance Measures**

Key Objectives: Key objectives of the SUITE Measurement and Analysis process include:

- Assessing project performance, through variance indicators (cost; schedule; scope) as they relate to SUITE component usage (e.g. Systems Engineering Methodology (SEM); Project Management Methodology (PMM))
- Assessing project quality improvements through defect trend metrics
- Tracking project alignment with business goals

Types of Performance Measures: There are three types of performance metrics used in the SUITE Measurement and Analysis Process.

Project Metrics:
- Track project progress against original estimates
- Assess project status to determine if the project is on schedule; in trouble; etc.

Product Metrics:
- Determine product quality (high quality vs. low quality)
- Identify defect rates
- Ensure adequate product performance

Process Metrics:
- Do more with less (shorter schedule, fewer resources)
- Quality improvement (fewer defects, less re-work)

Measurement Categories: There are several measurement categories that are used in the SUITE Measurement and Analysis Process. Current measurement categories include budget/cost performance, schedule performance, product quality, redundancy, and compliance. A portion of this information is captured on the Project Metrics Collection Form (SEM-0188). Additional metrics will be captured by the PPQA project review teams, as well as other sources.

Budget/Cost Performance (project-based):
- Planned vs. actual
  - Dollars planned vs. dollars spent

Schedule Performance (project-based):
- Planned vs. actual
  - Milestones completed on time
  - Project completed on time

Product Quality (product-based):

- Defects identified through quality activities
  - Number of defects by type during each SEM Stage
  - Number of defects by type during first 30 days in production

Redundancy (product-based):
- Number of eliminated or duplicate/overlapping systems
- Decreased number of duplicate data elements

Compliance (process-based):
- Number of non-compliance findings by category identified by Process and Product Quality Assurance (PPQA) project reviews

Future metrics categories may include:

Productivity (project-based):
- Time taken to complete tasks
- Number of deliverables produced

Customer Satisfaction (product-based):
- System availability (up time)
- System functionality (meets *agreed to* customer / user requirements)

It is anticipated that additional measurement categories will be added as SUITE processes mature.

Section: **3.0 Metrics Collection and Storage**

The purpose of *Measurement and Analysis* is collecting objective data which, through appropriate analysis, can provide management information to support decisions that will lead to the successful accomplishment of the business objectives of the department. Metrics must be tailored to provide insight into the operational project objectives and needed support levels that will maintain alignment with the client's business objectives and priorities. These metrics will also maintain alignment with the MDIT and business unit strategic objectives for the State of Michigan.

Metrics Collection Tools and Process:

One tool to collect SUITE-based metrics is the Project Metrics Collection form (SEM-0188). This form is to be completed for all projects using SEM and SEM Express – in conjunction with the PMM.

This form's function is to collect metrics data on projects for the purpose of tracking overall trend data in an effort to evaluate the effectiveness of SUITE-related processes and to measure product quality.

The SEM-0188 is to be completed by the project manager within 45 days after the system has been released to the production environment and available to system users. This 45-day delay is important, as it allows for the capture and analysis of the first 30 days of production defect counts.

The SEM-0188, once completed, is to be sent to suite@michigan.gov. For routing purposes, include "SEM-0188" in the subject line of the email.

A process will be developed to ensure that this form is completed for each project using the SUITE processes.

Form Data:

The Project Metrics Collection form (SEM-0188) contains sections requesting two different types of measurement data:

- Project-based derived measures (includes estimates and actuals so that we can identify variance trends associated with size)
  - Cost Variance
  - Milestone Variance
  - Project Schedule Variance
- Product-based measures
  - Defects found during each SEM stage
  - Defects found within 30 days after system release (in production)

See the SEM-0188 for instructions on completing these sections of the form.

Data Collection Tools:

At the present time, the tool being used to collect project and product metrics is the Project Metrics Collection Form (SEM-0188). Tools used to collect the metrics that appear on this form vary from area to area, and include spreadsheets, databases, COTS software applications, Remedy, and others.

The tool used to collect process compliance metrics is being developed by the Process and Product Quality Assurance (PPQA) Team.

As SUITE processes mature, methods for data collection will also mature to establish a standard for tools in order to promote efficiency and effectiveness.

Storage of SUITE Metrics Data:

After the Project Metrics Collection Form (SEM-0188) has been completed and sent to suite@michigan.gov, the information is then entered into a spreadsheet by SUITE project staff. Detailed project-specific data is not published or shared beyond each respective systems development unit. The data is consolidated and made generic for reporting and trend analysis purposes.

The long-term goal is to use Microsoft Sharepoint to house all metrics data. At the time of this writing, an enterprise repository pilot using Sharepoint is underway.

Section: **4.0 Measurement Analysis and Results**

Measurement Data Analysis: In order to support management decisions and improvement plans, collected measures must be analyzed. Review and analysis of SUITE metrics can identify problem areas, such as the accuracy of forecasting.

The analysis of collected process measures allows a team to review various activities and identify opportunities for process improvements. Metrics analysis can be a very complicated undertaking. As the process matures the level and types of analysis will as well. Analysis techniques such as cause and effect mapping, control chart analysis, and other tools of quantitative software measurement and statistical process control can be introduced from the initial data collection activities. Initially, the *Measurement and Analysis Process Manual* focuses on **trend** and **compliance** data in an effort to show project, product, and process improvements over time using trend analysis, and to provide MDIT management with objective insight as to usage of the SUITE processes.

The aggregated results of the metrics analysis must be communicated throughout the department and to key business personnel as appropriate. This will provide support for the collection process as team members see the results of their efforts. each team will see how the results of various improvement efforts affect the success in meeting the objectives of the department.

Project-Based Analysis: Project based metrics are aggregated to create average and median data. This data is then graphed to show changes over time in project efficiencies due to the use of SUITE processes. These changes are due to increased scope control, better estimation techniques, better issue resolution techniques, and better adherence to business and project requirements.

Project-based trend data shows two major categories: Cost and Schedule.

Cost:
Cost variance is plotted graphically to show increased/decreased cost estimation. Cost estimates are based on two factors – utilization of good budget/cost estimating techniques and scope management (disallowing unapproved project work).

Schedule:
Schedule variance is plotted graphically to show increases/decreases in of project schedule estimates. There are two schedule variance categories: **milestone** and **project**. Milestone variance shows how well projects are keeping to their deliverable schedules. This can give an indication of how early in the project schedule slippage occurs. Project schedule variance is an overall indication of when the timelines of project completion.

Product-Based Analysis:

The two types of metrics that can be collected as part of product-based analysis are: **defect identification/analysis** and **redundancy reduction**.

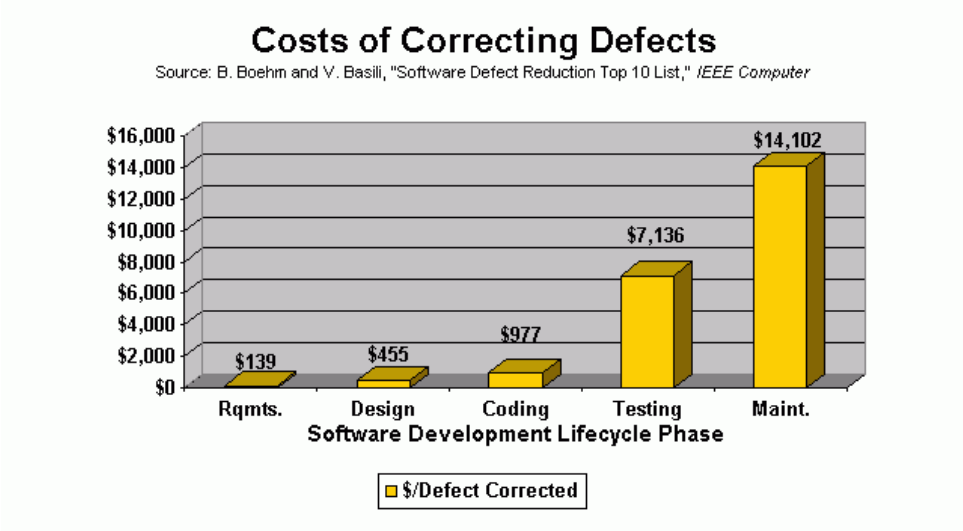
Defect Identification/Analysis

Product based metrics are aggregated to create average and median data. This data is then graphed to show changes over time in project quality due to the use of SUITE processes. These changes are due to the use of processes that promote defect identification as early as possible in the system life cycle.

This product-based trend data shows two major categories: defects found during the stages of systems development/maintenance, and defects found in production.

There are several trends that would show increased value as a result of finding defects earlier in the process. A positive trend would be to find the number of defects in development going up and the number of defects found in production going down.

Further, it would be better to find more defects during the initial stages of systems development as opposed to later stages in development. It is important to note that finding and reporting defects are opportunities to improve processes, thus introducing improvements in product quality. See diagram below.



Redundancy Reduction:

Data that substantiates redundancy reduction is obtained from validation of the Project Charter's Purpose Statement or Project Objectives sections, or by discovery during development and implementation. This metric may not be applicable to all projects.

At the completion of the project, often during the Project Closeout Phase of the project, the Project Charter is examined to ensure that all of the objectives of the project were satisfied. The Post Implementation Evaluation process, using the

Post Implementation Evaluation Report (PMM-16 or PMM-16 EXP), can be used to identify and document redundancy reduction.

Process-Based Analysis:

This metric is captured only if the project has received a review from a Process and Product Quality Assurance (PPQA) project review.

A PPQA Review Team will conduct an objective analysis of process compliance by the project team. At the conclusion of this review, the PPQA Review Team will give the project manager a report of their findings. This report will detail any non-compliance issues found, and will give tips on how to bring this, or future, projects into compliance.

Reporting of Findings:

Aggregated project-, product-, and process-based analyses are initially reviewed by SUITE support staff for completeness and reasonableness. They are then shared with the SUITE sponsors and other interested parties.

For the first several reporting periods, the analysis consists of working with potentially incomplete data, as these metrics were not captured in the past and may not be available for all stages of the systems development effort. Another challenge is receiving the Project Metrics Collection Form (SEM-0188) in a timely manner from project managers that managed these projects, as this is a new process that is being implemented.

Much of the aggregate data will be used in trend analysis to show the benefits of SUITE process improvements. It is anticipated that this data and information will also be used for benchmarking with other organizations.

Management reports will be developed over time, as the SUITE initiative matures.

Section: **5.0 Bibliography**

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Appendix A – Key Terms and Acronyms

Configuration Item	An aggregate of hardware, software, or documentation components that are designated for configuration management and treated as a single entity in the configuration management process.
Indicator	An indicator is a metric or combination of metrics that provide insight into a process, a project, or product, to enable assessment and improvement. This is an interpretation of a metric or combination of metrics.
Measure	A measure is the result of the activity involved in determining dimension, i.e., size, etc. through measuring. Measures should be objective, timely, simple, accurate, useful, and cost effective.
Metric	A quantitative measure of the degree to which a system, component, or process possesses a given attribute.
Performance	The execution or accomplishment of work.
Performance Measurement	The ongoing monitoring and reporting of process, project, or product accomplishments, particularly progress towards pre-established goals. Performance measures may address the type or level of activities conducted (process); the direct products and services delivered; and or the results of those products or services (outcomes).
Process and Product Quality Assurance	Process area introduced starting with CMMI Level 2 that provides staff and management with a methodology to acquire objective insight into processes and associated work products.
Production Environment	Where an application or system resides that hosts actual / real data (as opposed to test data) or is available on a publicly accessible network or server.
Quality Assurance	A planned and systematic means for assuring management that the defined standards, practices, procedures, and methods of the process are applied.
Repository	A place where data or specimens are stored and maintained for future retrieval.
SUITE	State Unified Information Technology Environment

Appendix B – Project Metrics Collection Form (SEM-0188)

State of Michigan

(Insert Project Name Here)

Project Metrics Collection

INSTRUCTIONS: This form is to be completed for all systems-related projects. This form's function is to collect metrics data on projects for the purpose of tracking overall trend data in an effort to evaluate the effectiveness of SUITE-related processes.

This form is to be completed by the Project Manger 45 days after the system has been released to the production environment and available to system users.

Send the completed form to suite@michigan.gov (include "SEM-0188" in the subject of the email to ensure proper routing).

Section I – Project General Information	
1. Project Name	2. Project Duration
3. Project Manager Name	4. Project Team Size
5. Client Agency/Division	
6. SEM, SEM Express, or Tailored Approach	

Section II – Project-Based Metrics

Cost

Metric: Cost Variance (Dollars Planned vs. Dollars Spent)
Formula: Actual Cost divided by Budgeted Cost (including all approved changes)
Example: $100,000 Budgeted; $112,000 actual (112,000 / 100,000 = Cost Variance of 1.12)
(Item 3 below is a calculated field and will populate when you click Update Fields on the DIT-0226 Toolbar or when the form is printed.)

1. Budgeted Project Cost	2. Actual Project Cost	3. Cost Variance
$0.00	$0.00	!Zero Divide

Schedule

Metric: Milestone Variance (Total Milestones vs Milestones Completed Late)
Formula: Number of milestones completed late divided by Total number of milestones
Example: 7 total milestones; 1 milestone completed late (7 / 1 = Milestone Variance of .14)
(Item 3 below is a calculated field and will populate when you click Update Fields on the DIT-0226 Toolbar or when the form is printed.)

4. Number of Project Milestones	5. No. of Milestones Completed Late	6. Milestone Variance
0	0	!Zero Divide

Schedule

Metric: Project Schedule Variance (Project Completed on Time)
Formula: Actual Days to Complete divided by Planned Days to Complete (including all approved changes)
Example: 24 days Planned; 19 days Actual (19 / 24 = Project Schedule Variance of .79)
(Item 3 below is a calculated field and will populate when you click Update Fields on the DIT-0226 Toolbar or when the form is printed.)

7. Planned Number of Project Days	8. Actual Number of Project Days	9. Project Schedule Variance
0	0	!Zero Divide

Stage / Dates	Initiation & Planning	Requirements Definition	Functional Design	System Design	Construction	Testing	Implementation
Stage Exit Original Planned Completion Date							
Stage Exit Rebaselined Planned Completion Date, if apaplicable							

Stage Exit Actual Completion Date							

Section III – Product-based Metrics

The following table includes defects (corrections) found during systems development (obtained from the SEM-0187, Structured Walkthrough Meeting Record).

For the table below, if SEM Express or a Tailored Approach was used, enter the date in the last applicable column (eg. For the Initiation, Requirements, and Design Stage, enter the dates in the System Design column).

Stage / Defect Category	Initiation & Planning	Requirements Definition	Functional Design	System Design	Construction	Testing	Implementation	Production	Totals
Code	0	0	0	0	0	0	0	0	0
Change of Scope	0	0	0	0	0	0	0	0	0
Cosmetic	0	0	0	0	0	0	0	0	0
Data	0	0	0	0	0	0	0	0	0
Design	0	0	0	0	0	0	0	0	0
Environment	0	0	0	0	0	0	0	0	0
Performance	0	0	0	0	0	0	0	0	0
Requirement	0	0	0	0	0	0	0	0	0
SCM	0	0	0	0	0	0	0	0	0
Security	0	0	0	0	0	0	0	0	0
Standards	0	0	0	0	0	0	0	0	0
Usability	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0
Totals	0	0	0	0	0	0	0	0	0