



**CMMI** Institute

# HOW TO APPLY PROCESS MINING TECHNIQUES IN SCAMPI APPRAISALS

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# INTRODUCTION

- Arthur Valle, PhD.
- I founded my own consulting company in 2000: TRENDSET Consulting
- 18+ years of **experience in Software Process Improvement**
- Former **CMMI instructor** and **consultant** (from ISD Brazil)
- **Currently**, an **academic staff member** at Wintec (Waikato Institute of Technology) **in New Zealand**
- Appraisal Team Member (ATM) in **several SCAMPI Classes A, B and C**
- In the beginning of my PhD degree I realized that I could **reduce my effort in SCAMPI appraisals** by using Process Mining

# PRESENTATION OUTCOMES

- Discuss some **limitations of SCAMPI appraisals/method**
- Understand **Process Mining (PM)**
- Understand **“Process Mining Extension to SCAMPI”**
  - a feasible, usable and useful method that reduces some limitations of the current SCAMPI method and defines which, when, where, how and why to apply Process Mining techniques in SCAMPI-based process appraisals
  - developed as an outcome of a PhD degree (Technical Report\*) and based on SSD-Service System Development process area from CMMI-SVC
- Understand the **verification and validation** of the extended method
- Identify **benefits** (and limitations) of applying Process Mining techniques in SCAMPI appraisals

\*available at <http://www.biblioteca.pucpr.br/pergamum/biblioteca/img.php?arquivo=/000059/000059bf.pdf>

# CONCERNS ABOUT SCAMPI

SCAMPI appraisals/method present **limitations\***, such as:

- SCAMPI appraisals are **inherently dependent on the appraisers and the competencies of appraisers**.
- SCAMPI appraisals are **long, complex, expensive and resource demanding** (especially regarding data collection and analysis tasks).
- SCAMPI method presents **subjectivity to analyze data and to judge about the implementation of practices**.
- SCAMPI method **does not provide confidence regarding sample selection and its representativeness**.

*\* according to an online survey answered by 25 SCAMPI appraisers and CMMI experts*

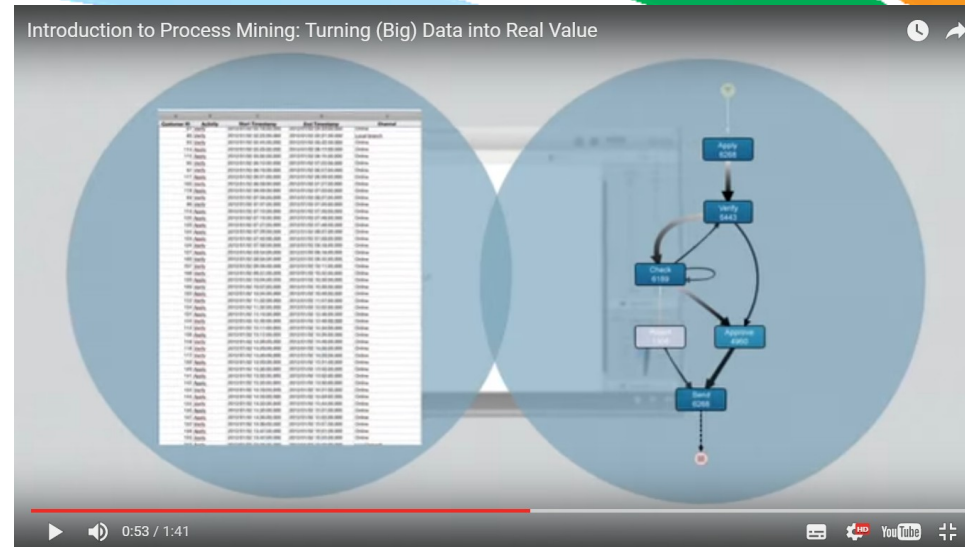
# PROCESS MINING

Process Mining is a relatively young discipline that sits between **data mining** and **process modeling & analysis**.

The idea is to **discover, monitor and improve real processes** (i.e., not assumed processes) by **extracting knowledge from event logs readily available in today's information systems** (VAN DER AALST, 2011).

It can be applied to aid **collecting and analyzing data in SCAMPI appraisals**.

However, there is a **lack of a method that defines what, when, where, how and why to apply Process Mining techniques in process appraisals**.



source: [www.processmining.org](http://www.processmining.org)

# OPPORTUNITIES

- To **reduce amount of effort and time** for data collection and analysis activities in SCAMPI appraisals.
- To **assess more process instances** than are typically done in current SCAMPI appraisals (i.e. increasing sample size).
- To **reduce subjectivity** when analyzing objective evidence and judging about reference model practices implementation.
- To use Process Mining algorithms and tools **to automatically identify the actual process being performed and its deviations from organizational policies, standard processes and reference models practices.**
- To **enhance data analysis techniques** in current SCAMPI method in order to also **evaluate aspects regarding who (and when) performed an activity, and in which order.**

# REQUIREMENTS FOR THE METHOD

## Requirements:

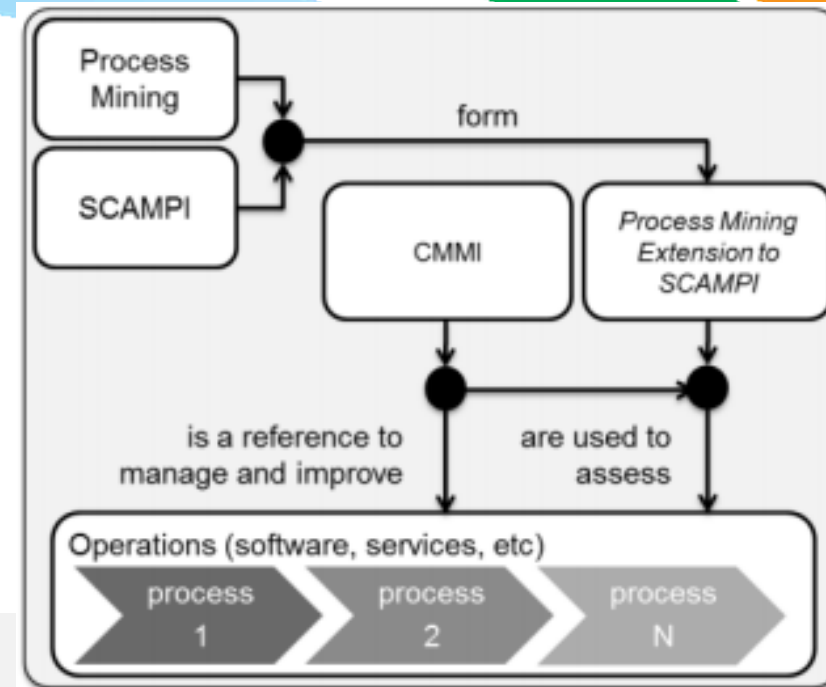
- Extended method should **reduce the dependency on appraisers and their competencies**.
- Extended method should **reduce the amount of effort and time of appraisal team** (especially regarding data collection and analysis tasks).
- Extended method should **reduce subjectivity to analyze data and to judge about the implementation of model practices**.
- Extended method should **increase confidence regarding sample selection and its representativeness**.

# PROCESS MINING EXTENSION TO SCAMPI

“Process Mining Extension to SCAMPI” is an extension to **SCAMPI<sup>SM</sup> v1.3b**: Method Definition Document for SCAMPI A, B, and C.

It is an extended method that **adds Process Mining techniques** - such as process discovery and conformance checking - **into SCAMPI method** to provide an explicit and focused basis for appraising an organization using such techniques **aiming to lead to more reliable and effective appraisals**.

**It does not intend to replace SCAMPI MDD.** Rather, it focuses on how Process Mining aspects affect the main content of SCAMPI, e.g. its processes and activities.





# PROCESS MINING EXTENSION TO SCAMPI: STRUCTURE

Phase	Process	Activities
1 Plan and Prepare for Appraisal	1.1 Analyze Requirements	<u>1.1.1 Determine Appraisal Objectives</u> <u>1.1.2 Determine Data Collection Strategy</u> 1.1.3 Determine Appraisal Constraints <u>1.1.4 Determine Appraisal Scope</u> 1.1.5 Determine Appraisal Outputs 1.1.6 Obtain Commitment to Initial Appraisal Plan
	1.2 Develop Appraisal Plan	<u>1.2.1 Tailor Method</u> <u>1.2.2 Identify Needed Resources</u> <u>1.2.3 Develop Data Collection Plan</u> 1.2.4 Determine Cost and Schedule 1.2.5 Plan and Manage Logistics 1.2.6 Document and Manage Risks 1.2.7 Obtain Commitment to Appraisal Plan
1.3 Select and Prepare Team	1.3 Select and Prepare Team	<u>1.3.1 Identify Appraisal Team Leader</u> <u>1.3.2 Select Team Members</u> 1.3.3 Document and Manage Conflicts of Interest <u>1.3.4 Prepare Team</u>
		<b>1.A Obtain Process Mining Artifacts and Elements</b> <b>1.A.1 Obtain Process Mining Artifacts</b> <b>1.A.2 Obtain Process Mining Elements</b>
		1.4 Obtain and Inventory Initial Objective Evidence 1.4.1 Obtain Initial Objective Evidence 1.4.2 Inventory Objective Evidence
		1.5 Prepare for Appraisal Conduct 1.5.1 Perform Readiness Review 1.5.2 Re-Plan Data Collection

2 Conduct Appraisal	2.1 Prepare Participants	2.1.1 Conduct Participant Briefing		
	<b>2.A Apply Process Mining Techniques on Objective Evidence</b>		<b>2.A.1 Familiarize and Filter Event log</b> <b>2.A.2 Discover Actual Process from Event Log</b> <b>2.A.3 Check Conformance of Event Log with <i>de Jure</i> Model</b> <b>2.A.4 Compare Conformance between <i>de Facto</i> model and <i>de Jure</i> Model</b> <b>2.A.5 Check Conformance to Business Rules</b> <b>2.A.6 Examine Process Mining results</b>	
			2.2 Examine Objective Evidence	2.2.1 Examine Objective Evidence from Artifacts 2.2.2 Examine Objective Evidence from Affirmations
			2.3 Document Objective Evidence	2.3.1 Take/Review/Tag Notes 2.3.2 Record Presence/Absence of Objective Evidence 2.3.3 Document Model Component Implementation 2.3.4 Review and Update the Data Collection Plan
			2.4 Verify Objective Evidence	2.4.1 Verify Objective Evidence 2.4.2 Characterize Implementation of Model Practices and Generate Preliminary Findings
			2.5 Validate Preliminary Findings	2.5.1 Validate Preliminary Findings
2.6 Generate Appraisal Results			2.6.1 Derive Findings and Rate Goals 2.6.2 Determine Process Area Ratings 2.6.3 Determine Process Area Profile 2.6.4 Determine Maturity Level 2.6.5 Document Appraisal Results	

3 Report Results	3.1 Deliver Appraisal Results	3.1.1 Deliver Final Findings 3.1.2 Conduct Executive Session(s) 3.1.3 Plan for Next Steps
	3.2 Package and Archive Appraisal Assets	3.2.1 Collect Lessons Learned 3.2.2 Generate Appraisal Record 3.2.3 Provide Appraisal Feedback to the CMMI Institute 3.2.4 Archive and/or Dispose of Key Artifacts
4 Action Plan Reappraisal	4.1 Action Plan Reappraisal	4.1.1 Plan Action Plan Reappraisal 4.1.2 Conduct Executive Session(s) Reappraisal 4.1.3 Report Action Plan Reappraisal

Underlined activities have **extended content** to current SCAMPI method.

**Bold** processes and activities are **new content** to current SCAMPI method.

Note that although in the chart only processes and activities are presented, **any derived element (such as inputs, outputs, tools and techniques)** could have been extended.

# PROCESS MINING EXTENSION TO SCAMPI: CONTENT (SAMPLES)

## 1.1 Plan and Prepare for Appraisal

### 1.1 Analyze Requirements

#### 1.1.1 Determine Appraisal Objectives

##### Process Mining extension:

After defining appraisal objectives, evaluate which appraisal objectives could be met by applying Process Mining techniques. Later on, such identified objectives will also be used to derive relevant questions that will drive the application of Process Mining techniques in the appraisal. Also, obtained Process Mining results will be later evaluated to check if they meet the objectives defined in this activity.

#### 1.1.2 Determine Data Collection Strategy

##### Process Mining extension:

Note that due to data-dependency nature of Process Mining, it is only applicable when selected data collection approach is "Verification".

The Data Collection Strategy for an appraisal aided by Process Mining should address the determination of Process Mining specific aspects, such as:

- Description of Process-Aware Information Systems (PAIS) available in the organization unit.
- Derived from the appraisal objectives that can be addressed by Process Mining, the questions that could be answered using Process Mining techniques. See appendix C for examples of questions. Note that Process Mining activities need to be driven by questions. Without concrete questions it will be very difficult to locate, select and extract meaningful event data.
- From identified questions, which Process Mining techniques could be used for collecting and examining Process Mining related artifacts. See appendix C for a list of typical questions.

#### 1.1.3 Determine Appraisal Constraints

#### 1.1.4 Determine Appraisal Scope

##### Process Mining extension:

From the defined reference model scope, select a subset of this scope to be examined using Process Mining techniques. There are some CMMI model components that are more suitable to be examined using Process Mining. For instance, when the implementation of particular process areas and their practices by an organizational unit involves the usage of information systems that support the conduction of such organizational processes, there is a higher probability to have event logs associated to these processes, which is a premise for Process Mining. Criteria to be used in this selection could involve aspects such as:

## 2.A.3 Check Conformance of Event Log with *de Jure* Model

### Activity Description

Analyze the extent to which the process execution, as recorded in the event log, corresponds to the *de Jure* process model (either reflecting the organization's standard process or the defined process). The purpose of this activity is to pinpoint deviations and quantify the level of compliance.

### Required Practices

The appraisal team member(s) acting as Process Mining analyst(s) shall do the following:

- (ABC) load event log (if not already there)
- (ABC) load *de Jure* model
- (ABC) map activities in the event log to activities in the *de Jure* process models.
- (ABC) select and apply algorithm
- (ABC) check results
- (ABC) calculate fitness measure
- (ABC) identify process instances that deviate from *de Jure* model, and how

### Parameters and Limits

(ABC) The appraisal team must evaluate the content of Process Mining artifacts to determine how they support model practice or model component implementation.

Note that two different *de Jure* models could exist. One reflects organization's standard processes while the other reflects defined processes.

Appraisal team member(s) performing process analyst role should identify which Process Mining algorithm to apply. There is a recommendation to use Conformance Checking algorithm. For a reference about main Process Mining algorithms see appendix F.

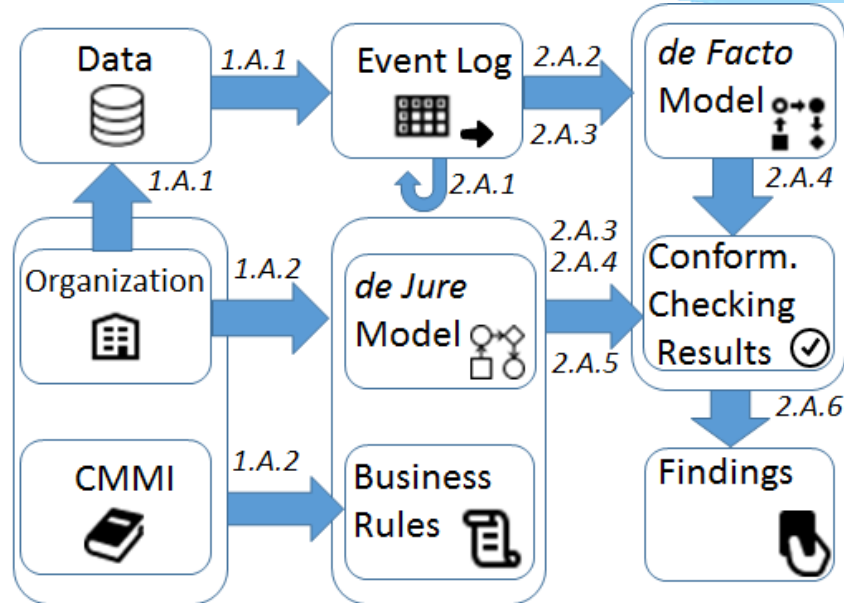
As a reference, value for fitness indicator should be as high as possible (i.e. a value higher than 0.8 is desired).

(ABC) This activity does not replace the activity 2.2.1 Examine Objective Evidence from Artifacts. In fact, it complements that activity using Process Mining techniques as an addition form to examine objective evidences aiming to determine the extent to which model practices or model components have been implemented in the organizational unit.

### Implementation Guidance

Conformance can be checked by using metrics to determine the extent to which the behavior observed in the event log complies with the *de Jure* model. Such analysis is performed by establishing a one-to-one mapping

# PROCESS MINING EXTENSION TO SCAMPI: HOW IT WORKS



## (new) Process Mining Activities:

- 1.A.1-Obtain Process Mining Artifacts;
- 1.A.2-Obtain Process Mining Elements;
- 2.A.1-Familiarize and Filter Event log;
- 2.A.2-Discover Actual Process from Event Log; 2.A.3- Check Conformance of Event Log with de Jure Model;
- 2.A.4-Compare Conformance between de Facto model and de Jure Model;
- 2.A.5-Check Conformance to Business Rules; 2.A.6- Examine Process Mining Results.

## Process Mining Elements:

*de Facto* model: process model that reflects the actual process being performed.

*de Jure* model: process model that reflects the expected behavior of a process

# PROCESS MINING EXTENSION TO SCAMPI: METHOD APPLICATION

The application of the extended method was done through:

- **Case Studies** (applying the method in real situations **to verify the method**)
- **Experts' Review** (to **validate the method** by obtaining a judgment from specialists regarding the usability, feasibility and utility of the proposed method)

# VERIFYING THE METHOD: CASE STUDIES

Conduction of 2 SCAMPI C appraisals using the extended method in 2 different organizational units of an IT company in Brazil:

**Case A** - recommended minimum number of instances: **10 process instances** (as per SCAMPI formula)

**Case B** - all instances: **All 1911 process instances available** (minimum number required by SCAMPI formula was only 4 instances).

Both cases are related to **software maintenance operations**, whose lifecycles are supported by software applications, which **record data in a format readable by Process Mining tools**.

Both **SCAMPI Class C** appraisals aimed to identify the adherence to selected practices of **Service Delivery (SD)** process area from **CMMI-SVC**:

- SP 3.1 - Receive and Process Service Requests
- SP 3.2 - Operate the Service System
- GP 2.1 - Establish an Organizational Policy
- GP 3.1 - Establish a Defined Process
- GP 2.7 - Identify and Involve Relevant Stakeholders

de Facto process model (i.e. actual behaviour)

# VERIFYING THE METHOD: CASE STUDY A

Business rules

Process related Data

Event Log

Process Mining related activities

Outcomes of PM algorithms

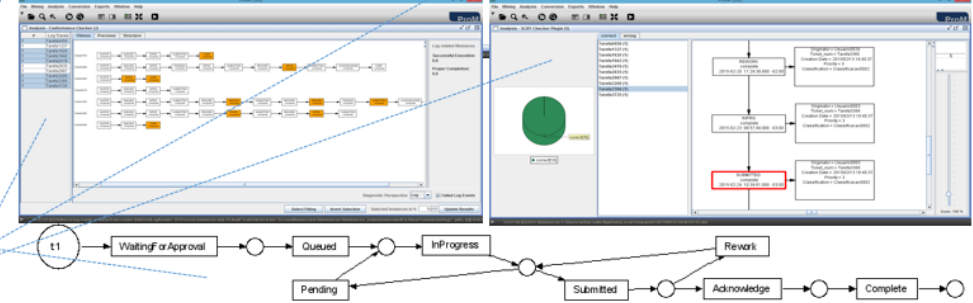
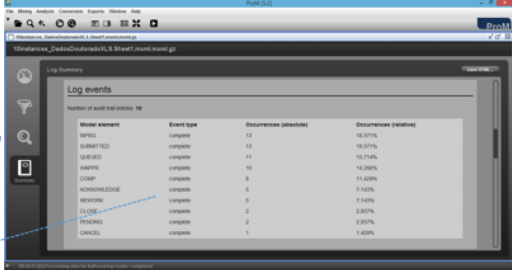
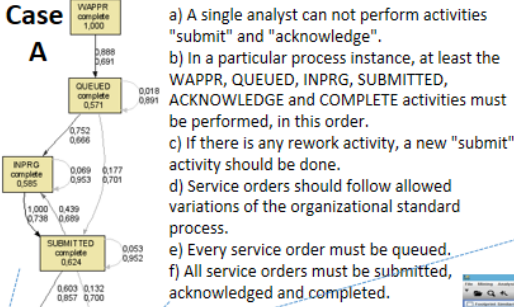
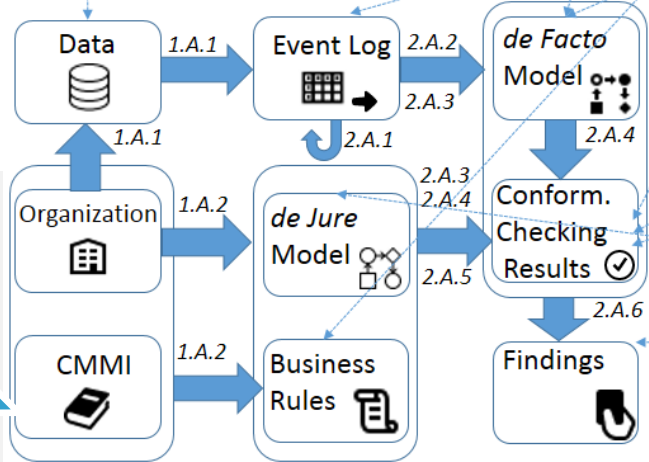
Method new activities and elements

de Jure process model (i.e. expected behaviour)

Appraisal findings

Ticket #	Ticket_num	Original Record	Priority	Classification	CreatedBy	Creation Date	Status History
1	Tarela001	OS001	3	Classificacao001	Pessoa001	Apr 15, 2015 7:50 AM	ACKNOWLEDGE
2	Tarela002	OS001	3	Classificacao001	Pessoa001	Apr 20, 2015 6:44 AM	ACKNOWLEDGE
3	Tarela003	OS001	3	Classificacao001	Pessoa001	Apr 6, 2015 4:57 AM	ACKNOWLEDGE
4	Tarela004	OS001	3	Classificacao001	Pessoa001	Apr 21, 2015 8:05 AM	ACKNOWLEDGE
5	Tarela005	OS002	3	Classificacao001	Pessoa002	Apr 24, 2015 9:34 AM	ACKNOWLEDGE
6	Tarela006	OS003	2	Classificacao002	Pessoa003	Apr 2, 2015 10:04 AM	ACKNOWLEDGE
7	Tarela007	OS004	3	Classificacao003	Pessoa004	Apr 18, 2015 12:49 PM	ACKNOWLEDGE

- Process Mining related activities:**
- 1.A.1 Obtain Process Mining Artifacts
  - 1.A.2 Obtain Process Mining Elements
  - 2.A.1 Familiarize and Filter Event log
  - 2.A.2 Discover Actual Process from Event Log
  - 2.A.3 Check Conformance of Event Log with de Jure Model
  - 2.A.4 Compare Conformance between de Facto model and de Jure Model
  - 2.A.5 Check Conformance to Business Rules
  - 2.A.6 Examine Process Mining Results



- GP 2.1: "The organizational policy item regarding minimum conduction of certain ordered activities in each service order was not followed in some of the selected service orders".  
 SD SP 3.1: "One selected service order has not queued the service request ticket".  
 SD SP 3.2: "Half of the selected service orders have not conducted submit, acknowledge and complete activities in the required order".  
 GP 3.1: "Some selected service orders have not completely followed the defined process".  
 GP 2.7: <none>

# VERIFYING THE METHOD: CASE STUDY A – PM ALGORITHMS

Case A

Comparison between De Jure and De Facto Models

Conformance checking between event log and De Jure Model

The screenshot displays the ProM software interface for conformance checking. The main window shows a table of log traces with columns for Log Traces, Fitness, Precision, and Structure. Below the table is a process flow diagram with nodes representing activities like 'WAAPR complete', 'SUBMITTED complete', and 'ACKNOWLEDGE complete'. To the right, a similarity matrix compares elements from the left and right models, showing a calculated similarity of 71.66%.

Element from left model	Element from right model
ACKNOWLEDGE (complete)	ACKNOWLEDGE (complete)
COMP (complete)	COMP (complete)
INPRG (complete)	INPRG (complete)
PENDING (complete)	PENDING (complete)
QUEUED (complete)	QUEUED (complete)
REWORK (complete)	REWORK (complete)
SUBMITTED (complete)	SUBMITTED (complete)
WAAPR (complete)	WAAPR (complete)

Calculate Similarity: 71,66 %

Business Rules Conformance Checking

# VALIDATING THE METHOD: EXPERTS' REVIEW

An online survey answered by **50 process improvement experts**.

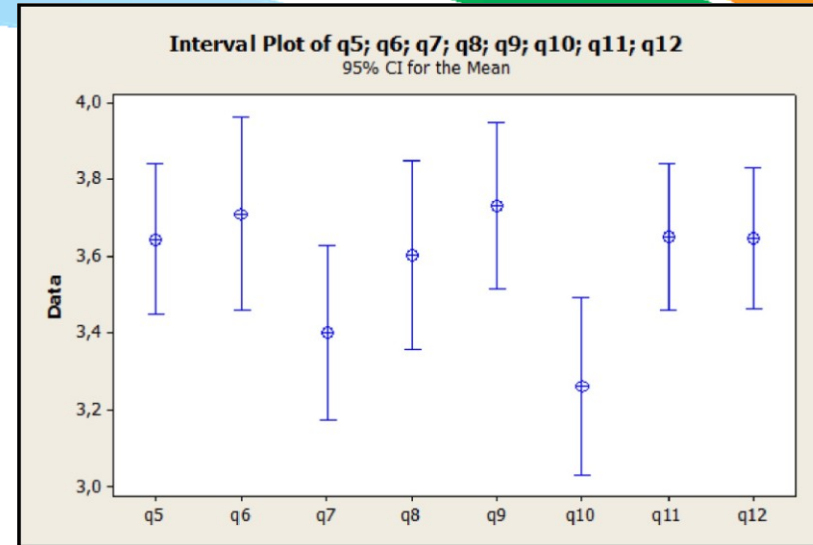
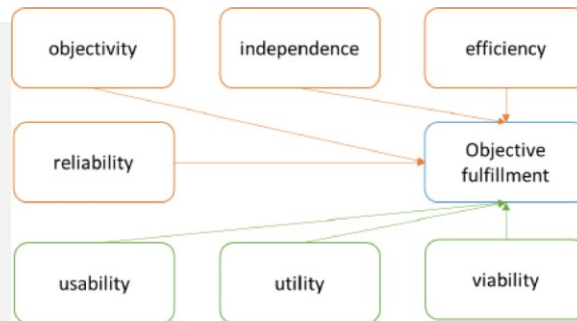
A **walkthrough demonstrating the method** - how it was developed and applied – **was also performed to selected respondents**.

Results shown that **extended method has better performance than the original SCAMPI method, as judged by the experts**.

**Only 10% of respondents said that they would not apply Process Mining techniques** in their future appraisals.

It was possible to prove - via **hypothesis testing** - that the extended method:

- **is feasible, usable and useful;**
- **reduces identified limitations of SCAMPI method.**



## One-Sample T: q5; q6; q7; q8; q9; q10; q11; q12

Test of  $\mu = 3$  vs not = 3

Variable	N	Mean	StDev	SE Mean	95% CI	T	P
q5	50	3,646	0,694	0,098	(3,448; 3,8429)	6,58	0,000
q6	50	3,712	0,882	0,125	(3,461; 3,963)	5,71	0,000
q7	50	3,402	0,800	0,113	(3,175; 3,630)	3,55	0,001
q8	50	3,605	0,861	0,122	(3,360; 3,849)	4,96	0,000
q9	50	3,732	0,764	0,108	(3,515; 3,949)	6,77	0,000
q10	50	3,262	0,809	0,114	(3,032; 3,492)	2,29	0,026
q11	50	3,652	0,673	0,095	(3,461; 3,844)	6,85	0,000
q12	50	3,648	0,650	0,092	(3,463; 3,833)	7,05	0,000



# LIMITATIONS

## Limitations:

- Due to the nature of Process Mining techniques, the adequacy of the **content of artifacts are not assessed** through the method;
- It is **not suitable to cover all process areas** of CMMI models or all specific and general practices in the “covered” process areas;
- The method requires **Process Mining competencies from the appraisers**;
- It requires the use of **specific Process Mining tools (ex: ProM, ProMimport and Disco)**;
- It requires **that process execution data to be collected and transformed prior to the conduction phase** of the appraisal;
- Performing SCAMPI appraisals aided by Process Mining is **restricted to organizational units where existing information systems record process-related data in specific format, quality and content as expected by Process Mining.**

# CONCLUSION

**Process Mining techniques can be applied with benefits in SCAMPI appraisals** because they reduce limitations as:

- time and effort for data collection and analysis;
- dependence on experience and competence of appraisers;
- unreliable sampling;
- subjectivity on judgment on the implementation of CMMI practices

“Process Mining Extension to SCAMPI” positions Process Mining as a **complementary approach (and substitute at some points)** to the traditional SCAMPI data collection & analysis techniques but also for judging on the implementation of CMMI practices

Appraisers and process analysts **can now rely on a guidance regarding identifying which Process Mining algorithms to use and how to apply them to answer the typical “questions” of software process assessment.**

# REFERENCES

- A.M.Valle Neto, E.A.P. Santos, E.F.R Loures. **Process Mining Extension to SCAMPI.** (2015) Technical Report  
<http://www.biblioteca.pucpr.br/pergamum/biblioteca/img.php?arquivo=/000059/000059bf.pdf>
- A.M.Valle Neto, E.A.P. Santos, E.F.R Loures. **Applying Process Mining Techniques in Software Process Appraisals.** Information and Software Technology (2017).
- W. van der Aalst. **Process Mining: Discovery, Conformance and Enhancement of Business Processes.** Springer-Verlag, Berlin (2011)

# ADDITIONAL SLIDES

- Case study B
- Future work

de Facto process model (i.e. actual behaviour)

# VERIFYING THE METHOD: CASE STUDY B

Business rules

Process related Data

Event Log

Process Mining related activities

Outcomes of PM algorithms

Method new activities and elements

de Jure process model (i.e. expected behaviour)

Appraisal findings

Number	Number	Opened	Closed	Priority	Value	Start	
1	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Accepted	2015/02/20 10:58:44
2	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Work in	2015/02/20 11:39:40
3	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Open	2015/02/20 10:44:19
4	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Open	2015/02/20 11:12:16
5	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Accepted	2015/02/20 11:26:06
6	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Resolved	2015/02/20 17:19:59
7	INC0579677	INC0579677	2015/02/20 10:43:29	2015/02/25 20:00:04	3 - Moderate	Closed	2015/02/25 20:00:04
8	INC0579677	INC0579677	2015/02/20 10:43:29	2015/03/05 20:00:02	3 - Moderate	Closed	2015/03/05 20:00:02
9	INC0596038	INC0596038	2015/02/28 14:21:36	2015/03/05 20:00:02	3 - Moderate	Open	2015/02/28 14:22:01
10	INC0596038	INC0596038	2015/02/28 14:21:36	2015/03/05 20:00:02	3 - Moderate	Resolved	2015/02/28 19:52:50
11	INC0596038	INC0596038	2015/02/28 14:21:36	2015/03/05 20:00:02	3 - Moderate	Accepted	2015/02/28 19:47:50
12	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Pending	2015/02/26 15:23:25
13	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Open	2015/02/25 15:45:51
14	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Accepted	2015/02/25 15:53:27
15	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Resolved	2015/03/10 17:43:36
16	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Closed	2015/03/15 20:00:03
17	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Work in	2015/02/25 15:55:09
18	INC0589858	INC0589858	2015/02/25 15:44:58	2015/03/15 20:00:03	3 - Moderate	Work in	2015/02/25 15:55:09

**Case B**

Process Mining related activities:

- 1.A.1 Obtain Process Mining Artifacts
- 1.A.2 Obtain Process Mining Elements
- 2.A.1 Familiarize and Filter Event log
- 2.A.2 Discover Actual Process from Event Log
- 2.A.3 Check Conformance of Event Log with de Jure Model
- 2.A.4 Compare Conformance between de Facto model and de Jure Model
- 2.A.5 Check Conformance to Business Rules
- 2.A.6 Examine Process Mining Results

a) In a given process instance, all activities should be performed, except Pending and Pending/Vendor activities which are optional.  
 b) A single analyst can perform all activities to address the incident, expect "open" activity that should be made by service desk.  
 c) Process instances should follow allowed variations from the organizational standard process.  
 d) Each incident should be opened and (then) accepted.  
 e) Every incident must be resolved and (then) closed.

**GP 2.1:** "the organizational policy item regarding conduction of mandatory activities for each incident was not followed in almost 25% of the tickets"  
**SD SP 3.1:** "2 out of 1911 tickets have not accepted the incident after opening the incident".  
**SD SP 3.2:** <none>.  
**GP 3.1:** "Most of all selected tickets have not completely followed the defined process".  
**GP 2.7:** "In all tickets, who opens the ticket also conduct other activities in the incident management lifecycle, which is not allowed".

# VERIFYING THE METHOD: CASE STUDY B – PM ALGORITHMS

Case B

Comparison between De Jure and De Facto Models

Conformance checking between event log and De Jure Model

The screenshot displays the ProM 5.2 software interface with three main windows open:

- Analysis - Conformance Checker:** Shows a Petri net model with transitions and places. A list of log traces is visible on the left, including identifiers like INC0519, INC0596, etc.
- Analysis - Differences Analysis:** Displays a comparison between provided and required behavior, with a Petri net diagram on the right showing differences in message mapping.
- Analysis - LTL Checker (4):** Shows the results of an LTL check for the formula `eventually_activity_A_next_B`. It lists parameters (A = Open, B = Accepted) and shows a list of process instances, with a detailed view of an incorrect instance (INC055925) and its corresponding Petri net state.

Business Rules Conformance Checking

# FUTURE WORK

## Future work:

- Development of studies regarding SCAMPI method in order to enable the judgment of **CMMI practices based on indicators or other quantitative criteria**;
- Improvement of the extended method aiming to guide on **coverage of specific practices and/or process areas of CMMI-SVC**;
- Evolution of the current focus of the extended method (i.e. conformance) for a method that **also examines performance and improvement aspects**;
- **Application of the method extended into new SCAMPI appraisal scenarios (e.g. SCAMPI B and A)**, to corroborate the findings presented here and allow other generalizations;
- **Application of the extended method in other scenarios**, such as internal and external audits;
- **Automation of Process Mining techniques in SCAMPI appraisals** through workflow automation tools such as RapidMiner ([www.rapidminer.com](http://www.rapidminer.com)).