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IMPLEMENTING PROCESS MINING TO IMPROVE COBIT 5 ASSESSMENT PROGRAM FOR MANAGING OPERATIONS (CASE STUDY: A UNIVERSITY BLOG)

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ABSTRACT

ISACA's COBIT is widely used to assess the maturity of process capability in many enterprises. It's last version is COBIT 5, which proposes a process assessment as a part of a process improvement initiative or as part of a capability determination approach. Two important steps of the COBIT 5 assessment process are data collection and data validation. This paper proposes process mining as a method to improve the traditional data collection and validation. An internal blog of a private university in Indonesia is analyzed as a case study to implement the model being proposed. The result shows that this model is proven as implementable in a real case of managing operations of a university blog. The resulted findings of the process mining can be combined with the findings of other assessment methods to enhance the result of the assessment program.

Keywords: *Process Mining, COBIT 5, Assessment Program, Data Collection, Log Data*

1. INTRODUCTION

For all enterprises, information is a key resource. It is created, stored, used, and destroyed mostly using technology. This makes information technology (IT) becomes one most important asset for enterprises. One important activity to ensure that IT processes are suitable to support business processes is by implementing process assessment.

As stated in ISO/IEC 15504-2:2003 [1], process assessment is an activity to be performed either as part of a process improvement initiative or as a part of a capability determination approach. The purpose of process improvement is to continually improve the enterprise's effectiveness and efficiency. While, the purpose of process capability determination is to identify the strengths, weaknesses and risk of selected processes with respect to a particular specified requirement through the processes being used and their alignment with the business need.

COBIT 5 provides a methodology for assessing the capability of IT processes [2]. Two important steps of the assessment process are data collection and data validation. In data collection step, the assessor obtains (and documents) an understanding of the processes including process purpose, inputs, outputs and work products, sufficient to enable and support the assessment. While, the data validation process is to ensure that the data are accurate and sufficiently cover the assessment scope to validate the information collected. Some data validation may occur as the data is being collected. [3]

Some data required for evaluating the processes within the scope of the assessment are collected by the information system. It is because information systems are becoming more and more intertwined with the operational processes they support. The process mining uses event data to automatically discover a process model by observing events recorded by some enterprise system. The process model is then compared with an event log of the same process, to check if reality as recorded in the log conforms to the model and vice versa. After the conformance checking, the process model can be extended or improved using information about the actual process recorded in some event log. [6]

This paper proposed process mining as a method to collect and validate data in the process assessment program. The assessors can use process mining to improve their methods in obtaining, analyzing and validating data based on event log data stored in the information system. It helps assessors to understand and model the process, to check the conformance of the process model to the

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reality, and to analyze the improvements potential for the recommendations. As a proof of concept, the model is implemented in a real case of managing operations of a university blog.

2. THEORY

2.1 Process Assessment Program

Part 2 of ISO/IEC 15504 [1] (Performing an assessment) is primarily addressed to the competent assessor and other stakeholders, such as the sponsor of the assessment. It sets out the minimum requirements for performing an assessment that ensure consistency and repeatability of the rating.

Process assessment is an activity that can be performed as part of a process improvement initiative or as part of a capability determination approach. The assessment process starts with the the assessment input which defines the purpose of the assessment (why it is being carried out), the scope of the assessment, what constraints apply to the assessment and any additional information that needs to be gathered. The assessment input also defines the responsibility of the various parties in the performance of an assessment. An assessor who has the necessary competence and skills oversees the assessment. Assessors may be from within the organization, external to the organization or a combination of both.

The requirements for process assessment form a structure which:

a) facilitates self-assessment;
b) provides a basis for use in process improvement and capability determination;
c) takes into account the context in which the assessed process is implemented;
d) produces a process rating;
e) addresses the ability of the process to achieve its purpose;
f) is applicable across all application domains and sizes of organization;
g) may provide an objective benchmark between organization.

The assessment overview in ISO/IEC 15504-2 is illustrated in Figure 1.

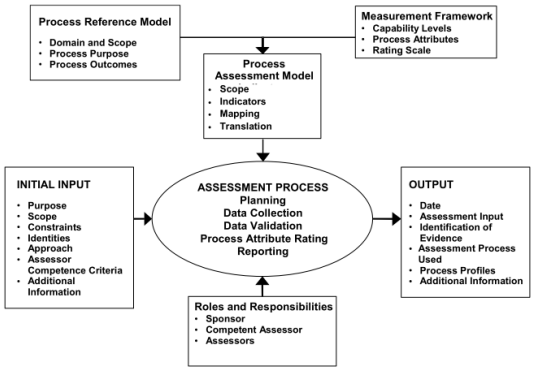

Figure 1. Assessment Overview [1]

Based on Figure 1, assessment process needs inputs as:

a) Process Assessment Model, which is build based on Process Reference Model and Measurement Framework
b) Initial Input
c) Roles and Responsibility

And results in some core outputs as: date, identification of evidence, process profiles, and additional information.

2.2 COBIT 5 Assessment Program

COBIT 5 [4] is a framework that assists enterprises to achieve their goals and deliver value through effective governance and management of enterprise IT. Enterprise boards, executives and management have to embrace IT like any other significant part of the business. COBIT 5 is generic and useful for enterprises of all sizes, whether commercial, not-for-profit or in the public sector.

The COBIT Assessment Program [3] brings together two proven heavyweights in the IT arena, ISO and ISACA. COBIT 5 provides a Process Reference Model in its Process Assessment Model documentation [5], as shown in Figure 2.

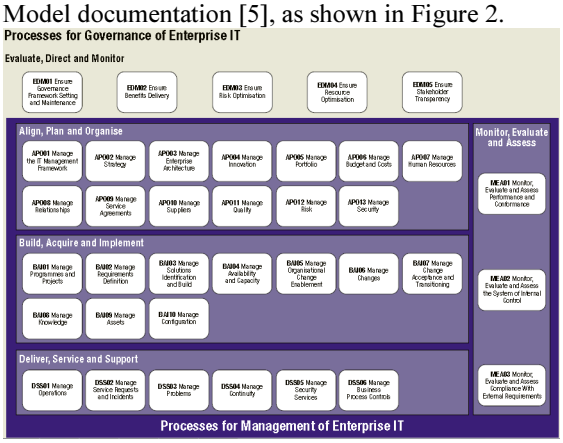

Figure 2.COBIT 5 Process Reference Model [5]

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As illustrated in Figure 2, COBIT 5 divides the processes of enterprise IT into two main areas of activity – governance and management – and subdivided into 37 processes. This Process Reference Model is used as one of the input as in Figure 1.

Another input in Figure 1 is measurement framework, which can be defined based on Process Assessment Levels (of ISO 15504) and Process Dimension (of COBIT 5). Figure 3 illustrated the combination of these components.

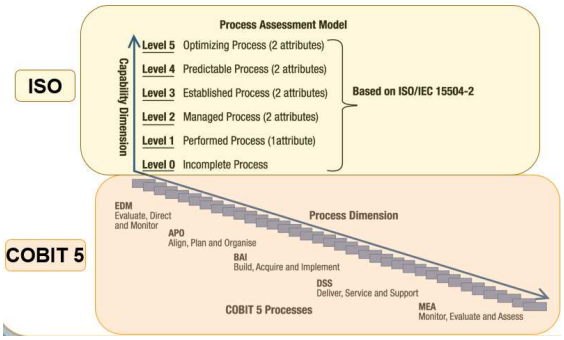

Figure 3. Measurement Framework [3]

While, the process attribute rating is assigned based on objective, validated evidence for each process attribute.

2.3 Assessment Process

The assessment processes, as shown in Figure 1, are:

1) *Initiation*; identify the sponsor, purpose, scope and additional information about the assessment.
2) *Planning the assessment;* describe all activities performed in conducting the assessment, resources needed, method of documenting the information, and coordination with the organizational unit being assessed.
3) *Briefing;* make sure that the assessment team understands the assessment input, process and output.
4) *Data collection;* obtain and document an understanding of the processes including purpose, inputs, outputs and work products, sufficient to enable and support the assessment.
5) *Data validation;* make sure that the data are accurate and sufficiently cover the assessment scope.
6) *Process attribute rating;* assign for each process attribute up to and including the highest capability level defined in the assessment scope.
7) *Reporting the result;* analyze and present the results in a report.

2.4 Process Mining

Process mining is a relatively young research discipline that sits between machine learning and data mining on the one hand and process modeling and analysis on the other hand. The idea of process mining is to discover, monitor and improve real processes (not assumed processes) by extracting knowledge from event logs readily available in today's systems. [6, 7, 8]

Process mining starts by gathering information about the processes as they take place, in the event logs. Any information system using transactional systems such as ERP, CRM, B2B, SCM and WFM systems will offer this information in some form [8]. Event logs may store additional information about events, such as the resource (person or device) executing or initiating the activity, the timestamp of the event, or data elements recorded with the event (the size of an order) [7]. This process log is used to construct a process specification, which can models the behavior of users using the system.

Event logs can be used to conduct three types of process mining. The first type of process mining is discovery. A discovery technique takes an event log and produces a model without using any a-priori information. Some techniques can be used to discover real processes merely based on example executions in event logs. The second type of process mining is conformance. The existing process model is compared with an event log of the same process. Conformance checking can be used to check if reality, as recorded in the log, conforms to the model and vice versa. Conformance checking can be applied to procedural models, organizational models, declarative process models, business rules/ policies, laws, etc. The third type of process mining is enhancement. The idea is to extend or improve an existing process model using information about the actual process recorded in some event logs. This type of process mining aims at changing or extending the a-priori model. For example, by using timestamps in the event log to extend the model to show bottlenecks, service levels, throughput times, and frequencies. [7] Figure 4 describes the three types of process mining in terms of input and output.

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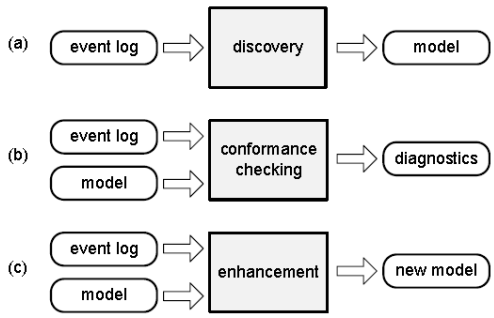

Figure 4. Three types of process mining [7]

Despite the applicability of process mining, there are still important challenges that need to be addressed [7], among others are:

1) Finding, merging and cleaning event data
2) Dealing with complex event logs having diverse characteristics
3) Creating representative benchmarks
4) Dealing with concept drift
5) Improving the representational bias used for process discovery
6) Balancing between quality criteria such as fitness, simplicity, precision, and generalization
7) Cross-organizational mining
8) Providing operational support
9) Combining process mining with other types of analysis
10) Improving usability for non-experts
11) Improving understandability for non-experts

In this research, important challenge is as mentioned in number 9 (Combining process mining with other types of analysis). The analysis needed in audit or process assessment is more than just based on transactional data in event logs, but should be combined with interview results, documentation review, and observation logs.

2.5 Process Mining for Audit

Some papers had documented efforts in implementing process mining in practical auditing/ process optimization in various case studies [9-19]. These papers show the awareness of implementing process mining for various purposes, including for supporting audit and process optimization. Especially from the organizational perspective, process mining is proven to be useful for understanding and modelling business processes for further analysis and improvement.

Rafael Accorsi implemented process mining as a basis for security audits of business process and corresponding business process management systems [9]. The main finding of this research is that process discovery generally provides an adequate basis for various sorts of security analysis. However, three drawbacks exist: lack of tools to analyze the structures produces by process discovery algorithms, lack of support for several desirable structures relevant for security analysis, and missing precision issues regarding the structures for the most approaches.

W.M.P. van der Aalst et al [10] describe the application of process mining in one of the provincial offices of the Dutch National Public Works Department, responsible for the construction and maintenance of the road and water infrastructure. This research shows that the practical application of business process mining is already feasible using the techniques embedded in the ProM framework. The case study showed that it is worthwhile to combine different mining perspectives to reach a richer understanding of the process.

Fabio Bezerra et al [11] present how ProM tools can support anomaly detection in logs of PAIS (Process Aware Information System) [16-19]. PAIS illustrates a shift from data to process-oriented systems, which clearly separates business process logic from application programs, facilitating redesign and extension of process models. The presented anomaly detection approach is limited to the control-flow perspective. Data and organizational perspectives should also be considered to provide more accuracy, and require a more complex anomaly detection framework. The selection of an appropriate model needs the definition of a precise appropriateness metric. Another conclusion is that an automated solution might be implemented, for example, through the use of genetic algorithms.

3. MODEL DESIGN

The design of the proposed research is based on the framework of ISO/IEC 15504 on the assessment program. Figure 5 illustrated the design of the proposed model.

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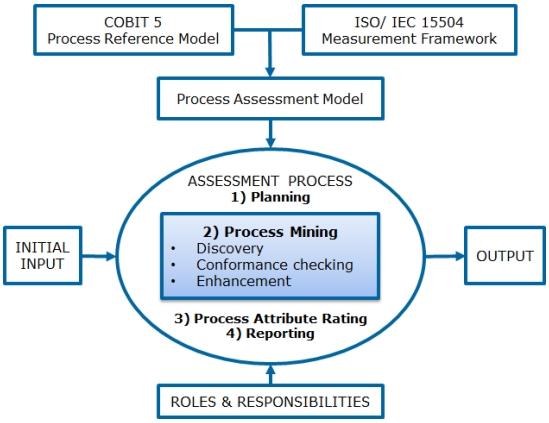

Figure 5. The Model Design

In general, the research build a model for implementing process mining in IT audit using COBIT 5. The assessment process framework of ISO/IEC 15504 is being used a general framework. The model will combine COBIT 5 Process Reference Model and ISO/IEC 15504 Measurement Framework, and guide the implementation of process mining.

COBIT 5 Process Reference Model (PRM) will be used especially for defining domain and scope, process purpose and process outcomes. The ISO/IEC 15504 Measurement Framework (MF) will guide in defining capability levels, process attributes and the rating scale. The Process Assessment Model (PAM) should define the scope, indicators, mapping and translation of COBIT 5 PRM and ISO/IEC 15504 MF into the assessment process. Initial input for the assessment process are information about the process, which are: the purpose, scope, constraints, identifiers, approach, assessor competence criteria, and other additional information. The assessment process needs the roles and responsibilities of the sponsor, competent assessor, and the assessors. Output of the assessment process are the date, assessment input, identification of evidence, assessment process used, process profile, and other additional information.

4. IMPLEMENTATION

The implementation of assessment process is done on Managing Operations of a university blog.

4.1 Assessment Process

The first phase of the assessment process is planning phase. The planning phase is done based on COBIT 5 Process Reference Model (PRM) and ISO15504 MF (Measurement Framework).

Based on COBIT 5 PRM, specifically DSS01 Manage Operations, the process coordinates and executes the activities and operational procedures required to deliver internal IT services in form of blog, including the execution of predefined standard operating procedures and the required monitoring activities. The process purpose is to deliver IT operational service outcomes of the blog as planned.Process goals and metrics of Managing Operations of a university blog based on DSS01 are in Table 1.

Table 1. Process Goals And Metrics Of DSS01

Process Goal	Related Metrics
1. Operational activities of a university blog are performed as required and scheduled.	• Number of non-standard operational procedures executed • Number of incidents caused by operational problems
2. Operations in a university blog are monitored, measured, reported and remediated.	• Ratio of events compared to the number of incidents • Percent of critical operational event types covered by automatic detection systems

The university blog is a facility for students, lecturers and employees of the university to post academic-related articles. The user types are lecturer, student and employees with different privileges. The blog service provider is IT division of the university.

The flowchart of university blogging process, as documented in the standard operating procedure (SOP), is shown in Figure 6.

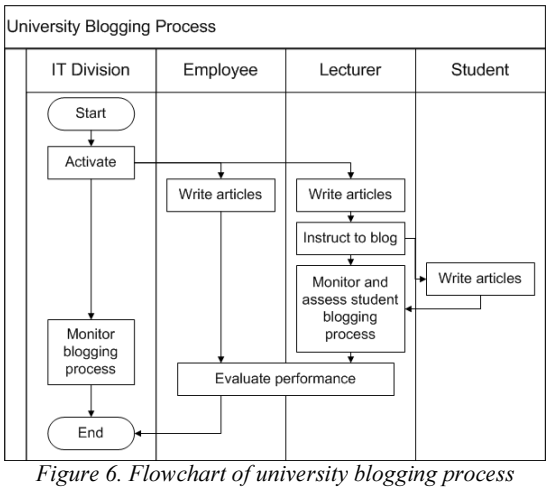

Figure 6. Flowchart of university blogging process

Based on the flowchart in Figure 6, university blogging process is analyzed by implementing process mining. The process is expected to perform

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as required and scheduled, monitored, measured, reported and remediated. The related metrics are focus on detecting the number of non-standard operational procedures and incidents caused by operational problems. IT service should be able to detect incidents by automatic detection systems.

4.2 Data Collection and Validation

Data collection and validation are done by implementing process mining. Data of the process implementation can be obtained from process event logs. The blogging process event log consists of 17383 events of an active semester in the university. Those events consist of some activities, *which* are: *blog_activation, new_blog_post, new_blog_comment, set_task, assess_task, set_eval, check_activities, new_avatar, friendship_created, created_group, joined_group, activity_update,* and *activity_comment.*

The data is then preprocessed to get a clean data in a proper form. In this case, the event log is preprocessed by:

1) Set timestamp (DD-MM-YY HH:MM:SS)
2) Sort based on *user id* and *timestamp*
3) Set MXML parameters (*case id, activity, timestamp*)
4) Convert into MXML format

Example of the preprocessing result is shown in Table 2.

Table 2. Example Of Preprocessing Result

id	user_id	component	type	date_recorded
1	1	blogs	new_blog_comment	07-04-12 13:11:28
2	1	friends	friendship_created	08-04-12 18:00:38
3	1	blogs	new_blog_comment	10-04-12 02:43:32
4	1	friends	friendship_created	10-04-12 14:39:50
5	1	friends	friendship_created	10-04-12 14:39:51
6	1	friends	friendship_created	10-04-12 14:39:52
7	1	friends	friendship_created	10-04-12 15:04:28
8	1	friends	friendship_created	11-04-12 03:13:52
9	1	friends	friendship_created	11-04-12 07:20:44
10	1	blogs	new_blog_post	11-04-12 09:45:45
11	1	activity	activity_update	12-04-12 03:01:14

The MXML formed data is ready to be analyzed using process mining. In this case, we use fuzzy mining plugin on ProM 5.2 framework [20].

The first type of process mining is discovery, which takes an event log and produces a model without using apriori information. The discovery of process mining results a process model as shown in Figure 7.

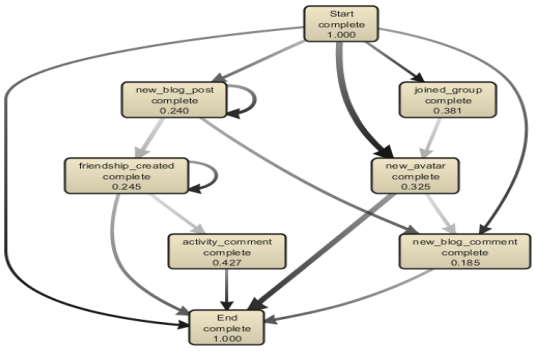

Figure 7. Process model of blogging process

Process model in Figure 7 can then be used to perform the conformance checking type of process mining. Conformance checking is used to check if reality, as recorded in the log, conforms to the model and vice versa. The conformance checking is done by checking recall, precision and F-measure parameters. The results are:

Recall = 1
Precision = 0.5675676
F-measure = 0.72413796

The recall value implies that the process model represents all events in the event log. The precision value is close to a middle (0.5) values, which means that the model is not too general nor too specific to a case.

The next type of process mining is enhancement, which extends or improves the existing process model using information about the actual process recorded in some event logs. For example, in the event log, we can find some event types of user *student* which are repeated more often than the others, which are:

1) *friendship_created → new_blog_post [30.1%]*
2) *activity_update → new_avatar [27%]*
3) *activity_update → new_avatar, new_avatar → activity_update, activity_update → friendship created [39%]*
4) *new_blog_post → check_activities (1.01%)*

Event type #1 is considered to be conformed to the expected process as shown in Figure 6, because a student is expected to write articles based on the lecturer instruction (*new_blog_post).* Event type #2 and #3 are not showing inconformity to the expected process, but the high percentage implies that some students are doing many activities in blogging process other that the main activity expected (write articles). Event type #4 is an example of inconformity to the expected process, because a student shouldn't be able to monitor blogging process (*check_activities).* This happens

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because the blog application is changed and added new features, including to grant permission for students to monitor blogging process. This permission is not covered yet in the standard operating procedure (SOP) of blogging process, but is lately considered to be added in the blogging application.

4.3 Process Attribute Rating

To define the process attribute rating, we need to combine the results of process mining with the data gathered from other data gathering methods, such as document review, interview and/ or questionnaire. The standard based on ISO 15504 to define the level of process capability is shown in Table 3.

Table 3. Standard level of process capability

Level	Achievement
N : *Not Achieved*	0 % – 15 %
P : *Partially Achieved*	15 % – 50 %
L : *Largely Achieved*	50 % – 85 %
F : *Fully Achieved*	85 % – 100 %

Based on COBIT 5, DSS01 (manage operations) is completed if conducting practices as follow:

DSS01.01 Perform operational procedures
DSS01.02 Manage outsourced IT services
DSS01.03 Monitor IT infrastructure
DSS01.04 Manage the environment
DSS01.05 Manage facilities

Two of five practices above can be answered based on process mining results only, which are DSS01.01 and DSS01.03. The other two (DSS01.02, DSS01.04, and DSS01.05) should be answered based on another data gathering methods.

Perform operational procedure (DSS01.01) has been implemented in the case study of university blog. The blogging process has been done based on the standard operating procedure (SOP), managed and verified based on the SOP. The rating can be done based on the result of enhancement process mining. The result shows that there is 1.01% inconformity to the expected process, which means that 98.99% of the process has been completed. According to Table 3, the process can be said as *fully achieved (FA)*.

Monitor IT infrastructure (DSS01.03) has also been done by storing sufficient chronological information in operation logs/ event logs. The event log enables the reconstruction, review and examination of the time sequences of operations and the other activities surrounding or supporting operations. This has been done in the case study through event log being analyzed. In other word, this practice is also *fully achieved (FA)*.

4.4 Reporting

Based on the planning through process attribute rating phase, some important finding to be reported are:

1) The university blogging process has been supported by a documented SOP. The implementation of the SOP should be monitored in more detailed way because there is inconformity found in the implementation.
2) Another finding shows that student as an actor of the blogging process still use the application for another purpose other than writing articles, as defined in the SOP.
3) IT division should check for the change management, because it is found that there is a change in the application (student now having the ability to monitor blogging process) which is not yet mentioned in the SOP.

5. CONCLUSION

Process mining can be used as a method for data collection and validation in the assessment process based on COBIT 5 and ISO 15504. The event logs in the information system can be used as the evidence for the assessment process. The process model discovered in the discovery type can be used to better understand the expected process of the system. The conformance checking phase helps the assessors to validate the process model to represent the real implementation of the process based on the event logs. The result of process mining, especially of the enhancement type, can be used to conclude the findings in the process attribute rating and reporting phase in the assessment process.

The result of process mining can be combined with the results of the other assessment methods, such as document review, interview and/ or questionnaire.

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