Using Enterprise Architecture for COBIT 5
Process Assessment and Process Improvement

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Abstract— The COBIT 5 best practice framework promotes Enterprise Architecture (EA) as a key process for helping to guide the creation and maintenance of governance and management enablers. These government and management enablers are sought as instrumental for providing assurance regarding the alignment between the business stakeholders’ needs and the information system solutions. Deficiencies in the required EA capabilities may hinder the effectiveness and efficiency of process assessment and process improvement initiatives. Indeed, the lack of organizational self-awareness forces the assessment stakeholders to engage a disproportionate amount of resources in wasteful evidence collection, evidence validation, and other interactive synchronization activities, thus leaving less resources for performing the actual optimization of the organizational enablers. In order to improve the outcomes of COBIT 5 process assessment and process improvement initiatives, we propose to integrate the COBIT 5 process rationale in the EA representations, using the standard ArchiMate Motivation Extension in order to promote easy adoption. We designed the EA solution using four iterations of the Design Science Research Methodology (DSRM) process model. This iterative learning approach enabled incremental improvements on each design cycle, regarding the definition of the solution’s objectives, the artifacts’ design, and the evaluation techniques. We demonstrate the proposal by applying in three field studies, in the context of two public sector organizations, using both ex-ante and ex-post scenarios. For the evaluation of this work we used the demonstrations, evaluation forms, as well as interviews and group sessions, in order to evaluate the goal efficacy, the environment consistency, and the structural quality of the proposed EA solution.

Keywords— COBIT, Enterprise Architecture, governance of enterprise IT, TOGAF, ArchiMate, business and IT alignment, design science, design science research methodology.

I. INTRODUCTION

The COBIT 5 framework [2] can be instrumental in providing a good practice approach for implementing GEIT initiatives, in order to maximize the value from IT investments, manage IT-related risks and achieve compliance [7].

The framework itself provides specific guidance for implementing governance using COBIT 5 [7]. This means that each successful COBIT 5 initiative may facilitate its own future path, by enhancing the capabilities required for supporting governance and management.

In particular, COBIT 5 recommends a set of processes that are instrumental in guiding the creation and maintenance of GEIT enablers. Among these processes, the APO03 Manage Enterprise Architecture is proposed as one of the key GEIT initiative enablers [7]. This recommendation should come as no surprise; indeed, Enterprise Architecture (EA) is instrumental for providing holistic organizational self-awareness [20], including relevant entities and their relationships, cutting across business domains, as well as bridging business and technology divides [21] [6] [22] [11] [1] [23]. Therefore, EA provides shared inter-domain knowledge and shared viewpoints, which enable different stakeholder to conduct effective conversations for engaging in compliance assessments [24] [25], risk management [15] [16], and change initiatives [26] [27] [28] [14] [29] [30] [13].

As related guidance for the APO03 process, the COBIT 5 frameworks recommends the TOGAF architecture framework, an Open Group standard [1]. The ArchiMate architecture modelling language [31], which is another Open Group standard, provides a good match for TOGAF [32], enabling the analysis and visualization of inter-related architectures, by providing views and viewpoints for addressing stakeholders’ concerns. Therefore, the COBIT 5 framework and the TOGAF standard are synergistic sources for requirements, regarding the enhancement of EA capabilities for enabling governance initiatives.

II. RELATED WORK

In the introductory section we have presented the COBIT 5 rationale for promoting EA, noting that the APO03 Manage Enterprise Architecture is proposed as a key process for helping to guide the creation and maintenance of governance and management enablers [3]. The purpose of the APO03 process is to “represent the different building blocks that make up the enterprise and their inter-relationships as well as the principles guiding their design and evolution over time, enabling a standard, responsive and efficient delivery of operational and strategic objectives” [20]. Therefore, the COBIT 5 framework provides the business case for improving EA capabilities, for the purposes of improving GEIT and thus enable value creation.
A. TOGAF

The APO03 Manage Enterprise Architecture process promotes TOGAF [15] as related guidance for an EA framework. The TOGAF Architecture Development Method (ADM), as well as other TOGAF components, map to the APO03 process key management practices [21].

The current TOGAF 9.1 specification recognizes the need for a tailored approach for COBIT, by stating that TOGAF tailoring “may include adopting elements from other architecture frameworks, or integrating TOGAF methods with other standard frameworks, such as ITIL, CMMI, COBIT, PRINCE2, PMBOK, and MSP” [15].

Therefore we can conclude that TOGAF is helpful in establishing capabilities that facilitate the implementation of GEIT initiatives and thus the achievement of the governance objectives and goals. However the standard TOGAF approach is generic, in the sense that it is not specifically tailored to the COBIT 5 rationale.

B. ArchiMate

The TOGAF and ArchiMate specifications are both developed by The Open Group, and their development efforts are becoming increasingly coordinated [28] [29] [30] [31] [32]. The ArchiMate standard is also widely supported by modeling tool providers [27] [28] [29] [30] [31] [32] [33] [34], which makes the language an attractive option for fast and easy adoption.

C. ArchiMate extensions

The language provides extension mechanisms to extend the core language, through adding attributes to ArchiMate concepts and relationships, as well as specialization of concepts and relationships [22]. Extending the ArchiMate language can be useful for optimizing the ontological fit of the architectural representations. Business concepts like organizational competencies [41] and key performance indicators [42] can be modeled using such an approach. Also, ontology-related techniques can be used assist the modeling of enterprise architectures through the analysis and validation of models [43].

However, in this work we aim to maximize the value of the COBIT 5 window of opportunity. So we based our artifacts on constructs that are an integral part of the ArchiMate specification, for fast and widespread adoption, thus facilitating the use of popular ArchiMate-compatible modeling tools. Other proposals have used the standards-based modeling approach that we adopt in this work, namely for modeling ITIL [44] [45], ITIL process assessments [46] [47], as well as security and risk [48].

III. RESEARCH PROBLEM

During the years 2014 and 2015, the author was engaged in GEIT initiatives using COBIT 5, which required assessing the performance of governance and management processes and providing recommendations on improving organizational capabilities. The experience thus gained by COBIT 5 practice demonstrated, we argue, how EA capabilities can be valuable for GEIT initiatives. Indeed, the lack of adequate organizational self-awareness and interactive synchronization tools forces the assessment stakeholders to engage a disproportionate amount of resources in the auditing and consulting activities, especially during the evidence collection and evidence validation iterations. Besides the efficiency penalty, resource-constrained initiatives will also suffer from effectiveness hindrances because less resources will be made available for performing the actual assessment, documenting exceptions and gaps, communicating the assessment conclusions, and optimizing the improvement recommendations and roadmaps [18] [17].

However, the current TOGAF standard does not provide specific architectural building blocks for COBIT 5. Note that TOGAF version 9.1 - currently the latest TOGAF release - was published in 2011, i.e. before the initial 2012-2013 COBIT 5 framework specifications were published.

Generally, the research problem may thus be defined as a search for a solution with the purpose of providing adequate EA capabilities, in order to assist process assessment and process improvement initiatives using COBIT 5.

IV. PROPOSALS AND DEMONSTRATIONS

The proposed solution was generated and tested using four iterations of a DSRM process model (see Figure VI-1) [5] [4] [3].

- First DSRM iteration: for the first DSRM iteration, we designed and tested a proof-of-concept EA proposal, in order to demonstrate and evaluate the feasibility of the scientific project as a whole, as well as to collect early feedback for the following DSRM iterations. For demonstration and evaluation purposes, an interim dissertation report was produced, presented, discussed, and evaluated at Instituto Superior Técnico, in a public session, as part of the formal evaluation process for the “Master Project in Information and Software Engineering” course. In the first DSRM iteration we proposed the initial set of solution objectives and requirements, which are work products of the first execution of the DSRM “Define Objectives of a Solution” research activity. We also proposed draft EA viewpoints, corresponding to outcomes of the first execution of the DSRM “Design & Development” research activity.

- Second DSRM iteration: For the second DSRM iteration, the generating and testing work was based on the following guidelines:
  o Field study: the study was performed in a military organization setting, in order to demonstrate and evaluate a new solution design for process assessments. We have also used a secondary group for experimental control purposes, made of MSc students.
  o We focused on the process capability level 1 rationale, i.e. process performance. Note that this capability level relates directly to the goals cascade methodology, therefore bringing the business-IT alignment perspective into play.
  o Demonstration and evaluation: we used an ex-ante demonstration and evaluation strategy, in
order to get early field study feedback for this interim iteration.

- Evaluation criteria: we have explicitly included goal efficacy evaluation criteria (see Table VI-1).

- Third DSRM iteration: For the third DSRM iteration, the generating and testing scope was changed:

  - Field study: a study was performed in the information systems department of a non-military large public sector organization. As for the previous iterations, we focused on artifacts for assisting process assessment activities.
  - Demonstration and evaluation: as the organization had already performed a process assessment based on COBIT 5, so we were able to demonstrate and evaluate the proposed solution using an ex-post setting.
  - We now addressed all five process capability levels. To this end, we prepared ex-post demonstration and evaluation artifacts up to the maximum capability level previously assessed in the organization – level 3. Therefore the artifacts related to the capability levels 4 and 5 were demonstrated and evaluated in an ex-ante setting. However, note that the capability levels 2 to 5 share, fundamentally, the same ontological structure, therefore allowing for ex-ante arguments to be made for the upper level (i.e. levels 4 and 5) based on the experimental outcomes for the lower levels (i.e. levels 2 and 3).
  - We have demonstrated the proposed solution (see Figure VI-5 and Figure VI-6, as examples of the artifacts) using four COBIT 5 processes, selected by a goals cascade exercise.
  - Evaluation criteria: we kept the same evaluation approach that was used in the second iteration, therefore allowing for a comparison between the second and third iterations’ experimental outcomes.

- Fourth DSRM iteration: For the fourth DSRM iteration, the generating and testing work focused on addressing COBIT 5 process improvement activities:

  - Field study: the field study was performed in the same setting of the third iteration, allowing for direct comparison between the two sets of evaluation ratings. As was the case for the previous iteration, all five process capability levels were addressed.
  - An additional solution requirement was defined for the design: links should be provided between the process assessment descriptions (third iteration) and the process improvement descriptions (fourth iteration), in order to leverage synergies between all related activities.

- Demonstration and evaluation: the demonstration for this iteration (see Figure VI-7 and Figure VI-8, as examples of the artifacts) was performed after performing the third iteration demonstration. However, we used a single evaluation form for recording the ratings of both the third and fourth iterations, in order to allow a more direct comparison between the two sets of evaluation ratings.

  - Evaluation criteria: we kept the same evaluation approach that was used in the second and third iterations, therefore allowing for a direct comparison between the second, third, and fourth iterations’ experimental outcomes.

V. EVALUATIONS

For evaluation purposes, we rated both the agreement with the problem/solution approach and the solution’s usefulness claims.

Regarding the research problem approach, we evaluated the agreement with the following statements:

- Enterprise Architecture is useful;
- The assessment/improvement criteria should be included in the diagrams;
- ArchiMate is useful for providing diagrams.

Regarding the solution’s usefulness claims, the evaluators provided ratings for the following evaluation criteria (see Table VI-1):

- Goal efficacy;
- Utility for the enterprise;
- Utility for people;
- Completeness, representation of all key concepts;
- Homomorphism, conformance with the modelled framework.

We have performed evaluation activities at each DSRM iteration:

- First DSRM iteration: for demonstration and evaluation purposes, an interim dissertation report was produced, presented, discussed, and evaluated (with a rating 19/20) at Instituto Superior Técnico, in a public session, as part of the formal evaluation process for the “Master Project in Information and Software Engineering” course. This evaluation activity provided validation concerning the general problem and solution approaches, the design methodology (i.e. DSRM), and the proof of concept artifacts.
• Second DSRM iteration: the evaluation ratings obtained in this iteration (military setting) are presented in Figure VI-2. The agreement ratings regarding the research problem approach are all positive, biased towards the “Strongly Agree” rating. The ratings related to the solution’s usefulness are overall positive, but we should note minor disagreement regarding the goal efficacy criteria.

• Third DSRM iteration: the evaluation ratings obtained in this iteration are presented in Figure VI-3. These results present an improvement in the goal efficacy rating, when compared with the second iteration. Note. However, that three criteria related to the ArchiMate language got lower ratings (non-military setting), namely “ArchiMate is useful for providing diagrams”, “Completeness”, and “Homomorphism”.

• Fourth DSRM iteration: the evaluation ratings obtained in this iteration are presented in Figure VI-4. All the evaluation criteria which are not directly related to the ArchiMate language got maximum ratings.

VI. CONCLUSIONS

In this paper, we have proposed a solution to enhance EA capabilities, in order to improve the efficiency and effectiveness of process assessments and process improvement initiatives using COBIT 5. The solution was demonstrated and evaluated in the settings of two large public sector organizations. The use of a DSRM process model allowed for the incremental improvement of the proposed solution, with good results for the final third (process assessment artifacts) and fourth (process improvement artifacts) iterations.

The proposed EA artifacts are based on standard ArchiMate constructs, in order to facilitate adoption and compatibility with existing ArchiMate tools, thus optimizing the proposed solution’s value. However, future work may try to understand the shortcomings of the ArchiMate language for COBIT 5, as well as propose improvements for future language versions.

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REFERENCES


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**Table VI-1: Evaluating the Solution’s Usefulness.**

<table>
<thead>
<tr>
<th>System Dimension</th>
<th>Evaluation criteria / sub criteria</th>
<th>Statement (claim) regarding objectives / requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Consistency with organization / Utility; Fit with organization</td>
<td>The Solution is useful for facilitating architectural conversations between the Assessment stakeholders, enabling a shared understanding of the assessment rationale (“why”) and providing a link for system implementation representations (“what”). Therefore, the Solution is useful to speed up the initial assessment activities (planning, data collection, and data validation).</td>
</tr>
<tr>
<td>Goal</td>
<td>Efficacy</td>
<td>The Solution is useful for facilitating architectural conversations between the Assessment stakeholders, enabling a shared understanding of the assessment rationale (“why”) and providing a link for system implementation representations (“what”). Thus, it may be used to improve the effectiveness of the assessment, by speeding up the initial assessment activities (planning, data collection, and data validation) and thus providing more resources for the value-added assessment activities (performing the actual assessment, documenting exceptions and gaps, and communicating the assessment results and conclusions).</td>
</tr>
<tr>
<td>Environment</td>
<td>Consistency with people / Utility; Understandability; Ease of use</td>
<td>The Solution is useful for providing an architectural representation of the Assessment rationale and providing a link to the system implementation. The graphical notation is easy to understand and the template is easy to use in practice.</td>
</tr>
<tr>
<td>Structure</td>
<td>Completeness [54]</td>
<td>The Solution is complete, meaning that it provides a template for representing all the key concepts required for process performance assessments: stakeholders, assessment result, process purpose, process outcomes, base practices, inputs, and outputs.</td>
</tr>
<tr>
<td>Structure</td>
<td>Homomorphism / Correspondence with another model [52] [53]</td>
<td>The Solution provides a model which conforms to the modeled assessment framework, presenting an adequate ontological mapping between the assessment concepts and the ArchiMate constructs.</td>
</tr>
</tbody>
</table>

**Figure VI-1: The DSRM Process Model.**
Figure VI-2: Evaluation results for the second DSRM iteration.

- Understanding the Problem and the Solution
  - Assessments
    - Enterprise Architecture is useful
    - The assessment criteria should be included in the diagrams
    - ArchiMate is useful for providing diagrams (process assessments)

- Rating the Solution’s Usefulness
  - Assessments
    - Utility for the enterprise
    - Goal efficacy
    - Utility for people
    - Completeness, representation of all key concepts
    - Homomorphism, conformance with the modeled framework

Figure VI-3: Evaluation results for the third DSRM iteration.

- Understanding the Problem and the Solution
  - Assessments
    - Enterprise Architecture is useful
    - The assessment criteria should be included in the diagrams
    - ArchiMate is useful for providing diagrams (process assessments)

- Rating the Solution’s Usefulness
  - Assessments
    - Utility for the enterprise
    - Goal efficacy
    - Utility for people
    - Completeness, representation of all key concepts
    - Homomorphism, conformance with the modeled framework

Figure VI-4: Evaluation results for the fourth DSRM iteration.

- Understanding the Problem and the Solution
  - Improvements
    - Enterprise Architecture is useful
    - The improvement rationale should be included in the diagrams
    - ArchiMate is useful for providing diagrams (process improvements)

- Rating the Solution’s Usefulness
  - Improvements
    - Utility for the enterprise
    - Goal efficacy
    - Utility for people
    - Completeness, representation of all key concepts
    - Homomorphism, conformance with the modeled framework
Figure VI-5: Third DSRM iteration: Process Capability Level 1 Performed process, for process APO12 Manage Risk

Figure VI-6: Third DSRM iteration: Process Capability Level 2 Managed Process, for process APO12 Manage Risk
Figure VI-7: Fourth iteration: Process Capability Improvement and GEIT View, for APO12 Manage Risk.

Figure VI-8: Fourth iteration: Process Capability Improvement View, Level 0 to Level 1, for process APO12 Manage Risk.