Abstract—SOA governance has a critical role in achieving success and realizing the benefits of SOA. Without effective SOA governance, organizations will experience some significant challenges including difficulties in designing effective decision structures and building a SOA roadmap, lack of service funding, lack of consistent governance processes and gap between IT and business. Study of existing SOA governance frameworks reveals that these frameworks do not completely document SOA processes, governance procedures and SOA roadmap, and also they are not expressive enough to cover all important elements of SOA governance. Therefore, in this paper, an enhanced and comprehensive SOA governance framework is designed, capable of providing more coverage of SOA governance elements such as governance structure and service lifecycle processes. The proposed framework is obtained by enforcing governance structures of COBIT and applying service management activities into a lifecycle approach. The proposed framework has been tested by comparing analysis with empirically measured values of SOA governance elements and analyzing with a comprehensive qualitative model. This framework offers a well-defined, structured set of aspects that an SOA governance framework should include and can delivers a comprehensive solution to help enable effective SOA governance.

 SOA Governance framework; SOA challenges; SOA roadmap; governance procedures

I. INTRODUCTION

Service Oriented Architecture (SOA) is an architectural approach for building applications by using a set of loosely coupled reusable, standards-based, and well-defined services [1]. However, most organizations face significant challenges and obstacles in their SOA implementation. The main challenges that organizations face with SOA adoption, are difficulties in designing effective decision structures, building a SOA roadmap, managing and governing services, integration of legacy applications, and also lack of service funding, lack of consistent governance processes and gap between IT and business [2]. In order to address the existing challenges and successful SOA adoption, organizations need exact definition of processes and relationships, control mechanisms, SOA metrics and enforcement of policies that are defined in SOA governance frameworks. A SOA governance framework defines the set of processes, organization structures, policies, solutions and technologies that can help to manage complex SOA deployment in an effective and efficient manner [3]. In SOA adoption process, a SOA governance framework enables companies to manage complexity, improve the ability to make better decisions, and develop the necessary maturity and infrastructure in the form of control and enforcement mechanisms. A number of SOA governance frameworks have been proposed by researchers and practitioners. However, our analysis shows a lack of well-documented SOA processes, policies, controls and metrics in these frameworks [4]. Also, the existing frameworks do not completely support imperative elements of SOA governance such as service portfolio management, governance structure and evaluation processes [4]. In the research reported in this paper, we have applied the problem-centered approach of the design science research methodology presented by Peffers et al. [5] while aligning the seven guidelines for design science defined by Hevner et al. [6] to develop a new SOA governance framework named AUT SOA governance framework. Figure 1 represents the main phases and used techniques of the development process of this new framework. The initial step is to understand targeted domain (e.g. SOA and SOA governance), and identify the main requirements, challenges and implications of SOA adoption. A summary of several commonly occurring problems and challenges in SOA adoption with a complete list of capabilities needed to address these challenges have been presented in [5]. In the next step, a set of important elements for SOA governance frameworks have been proposed. On the basis of these elements, six popular frameworks [7-12] have been compared and analyzed. In this comparison, we have considered COBIT as a comprehensive IT governance framework. The details of comparison results have been reported in [4]. The results from step 3 provide groundwork for designing a new SOA governance framework based on COBIT. This framework is iteratively developed, and also evaluated by applying it in a case study and qualitative evaluation with a comprehensive model. Further evaluations can be possible by practitioners when the framework is published in public domain.
The rest of the paper is organized as follows: in section 2, the AUT SOA governance framework with its related concepts has been introduced. In section 3, the main components of AUT SOA governance are briefly described. In section 4, we will describe evaluation of the proposed framework. Finally, in section 5, the conclusion and further works are presented.

II. AUT SOA GOVERNANCE FRAMEWORK

The concept of SOA governance has emerged as a way to implement control mechanisms in a SOA [13]. In order to successfully deploy SOA, organizations should put an internal control system or framework in place. The most essential topics in SOA governance that have been identified as SOA governance elements and reported in [4] can be placed in a framework to ensure a consistent transition from strategic considerations to delivery of the services. To help understand, design and communicate effective governance, we have used the IT Governance Design Framework defined by Weill and Ross [14]. According to this framework, each effective governance framework must harmonize enterprise strategy, governance arrangements and business performance goals. Enterprise strategy, governance arrangements and performance goals are enacted through IT organization and desirable behaviors, governance mechanisms and metrics. So, we have focused on business strategy and requirements and have designed AUT SOA governance framework including organization structures, SOA processes and procedures, control mechanisms and performance metrics. In AUT SOA governance framework, a set of practical and proven governance processes with service production and service management processes are integrated into a lifecycle approach. This framework has been derived based on the experiences of its authors, analysis of existing frameworks and combination of control and governance aspects of COBIT. COBIT is a widely accepted control framework for IT governance [15] that completely addresses evaluation processes, governance structure and control mechanisms, but do not support some important SOA governance elements such as service lifecycle, service portfolio management, SOA roadmap and SOA maturity. The proposed framework contributes to SOA governance needs by:

- Promoting the alignment of business and IT and supporting the business and IT drivers.
- Organizing service lifecycle and governance processes according to a general process model.
- Defining the management control objectives.
- Providing a SOA reference architecture and SOA infrastructure for using in developing and managing SOA solutions.
- Providing metrics and maturity models to measure achievement of defined goals.

Service lifecycle in AUT SOA governance framework is based on service lifecycle of ITIL® V3 framework [16]. SOA governance lifecycle is based on governance lifecycle of the SOA governance frameworks presented by IBM [10] and Open group [3]. Researches show that there are significant similarities between SOA service lifecycle and the ITIL® service management lifecycle [17]. While ITIL® provides the foundational layer to define processes for managing IT environment, processes and capabilities needed to integrate each phase of the lifecycle and processes to define and develop services [18], COBIT provides the control environment to ensure that processes are managed according to key goals and performance indicators, and also it guides management in deciding on the level of risk to accept, the most appropriate control practices and the path to follow when it is necessary to improve the level of control. So, interaction of ITIL and COBIT processes by applying SOA principles, suggests a full integration of portfolio management, enterprise architecture and SOA within the organization, through an overall governance framework. AUT SOA governance framework starts from business requirements. It is process-oriented that organizes SOA and service activities into a generally process model as shown in Figure II and defines relevant processes and activities of service lifecycle and SOA governance. Managing service lifecycle is at the heart of the proposed framework and ensures aligning IT services with business requirements. Governance lifecycle follows a number of phased activities and processes to govern and manage service lifecycle processes. The phases of the governance lifecycle should be viewed as a continuous improvement loop, whereby progress is measured, and course-correction and updates to the SOA governance plan and SOA governance roadmap are performed when needed. The phases of the governance lifecycle as illustrated in Figure II are Plan, Define, Implement and Measure.
In the Plan phase of governance lifecycle, SOA governance vision and strategy by assessing state and maturity of the current organization’s governance is established. The Define phase focuses on determining organization and governance bodies. Also, the gap between the current SOA governance and the target is analyzed and used to create a set of transition plans. These transition plans contain transformation initiatives for organizational, process, and technology areas that are required to deliver the objectives defined in the Plan phase. The Implement phase focuses on enabling and realizing the governance solutions and implements the transition plans including deployment of processes, organization, and technology aspects of the SOA governance. The Measure phase addresses performance management, monitoring of internal control, regulatory compliance and governance. These domains establish a governance model for managing service lifecycle activities that are categorized to four domains include service strategy, design, transition, and operation. These domains are concerned with the actual delivery of services, which includes service delivery, management of security and continuity, service support for users, and management of data and operational facilities. Internal pain points and external events are two different types of drivers and enablers that have been recognized for this framework. Costs growth, poor performance, stakeholder dissatisfaction and resource misuse are most important internal pain points and competitive market, customer demands, technology changes and business strategy are marked as external events. In order to control and evaluate services, and also fulfill business objectives and deliver value to customers, five major principles have been defined as service criteria including Functionality, Capacity, Performance, Compliance and Security. These criteria provide a basis for defining the business requirements and developing the metrics that allow measurement against defined goals.

III. CORE COMPONENTS OF SOA GOVERNANCE FRAMEWORK

The AUT SOA framework is established with the following core components that gives a complete picture of our framework. An overview of these components is described as follows:

A. Process Domains

AUT SOA Governance framework has four process domains and 10 processes in line with governance lifecycle, and also four domains and 16 processes related to service design, transition, and operation. These domains are concerned with the actual delivery of services, which includes service delivery, management of security and continuity, service support for users, and management of data and operational facilities. Internal pain points and external events are two different types of drivers and enablers that have been recognized for this framework. Costs growth, poor performance, stakeholder dissatisfaction and resource misuse are most important internal pain points and competitive market, customer demands, technology changes and business strategy are marked as external events. In order to control and evaluate services, and also fulfill business objectives and deliver value to customers, five major principles have been defined as service criteria including Functionality, Capacity, Performance, Compliance and Security. These criteria provide a basis for defining the business requirements and developing the metrics that allow measurement against defined goals.

The AUT SOA Governance Framework is shown in figure II.
Plan: This domain covers strategic planning and enablement of the SOA journey and also identifies needs and priorities of business.

Define: This process domain focuses on defining the SOA governance transition plans required to deliver the objectives defined in the Plan phase.

Implement: This process domain is concerned with implementing transition plans determined in the Define phase.

Measure: This process domain addresses performance management and internal control monitoring. Performance goals and metrics for all processes are defined and organization periodically reviews these metrics and makes the needed changes to governance policies, standards, and processes through iterations of the governance lifecycle.

In service lifecycle, the process domains as shown in figure II are called:

Service Strategy: This domain focuses on planning and prioritization of individual SOA solutions, and planning for the appropriate services, and also identifies needed changes to service portfolio.

Service Design: This process domain provides guidance on designing IT services, along with the governing processes and policies, and focuses on technology and architectures and measurement methods.

Service Transition: This domain provides guidance for the development of capabilities to transition new and changed services into operations also, focuses on service validation and testing, plan and prepare deployment.

Service Operation: This domain covers activities that govern the quality of services delivered to users, and the ability to monitor and report on the operational aspects of those services. Also it provides guidance on achieving effectiveness and efficiency in the delivery and support of services.

It is necessary to mention that these process domains, totally, contain 26 processes which are defined as new or changed COBIT processes by adding SOA principles. However, some COBIT processes have not changed and have not represented in our framework. These processes and their domains are as follows: Manage IT human resources and Assess and manage IT risks included in the Plan phase, Procure IT resources included in the Define phase, Manage third-party services and Manage the physical environment included in the Implement phase.

B. Process Management Guidelines

In the proposed framework, a set of process guidelines including process description, key activity goals, activities, generic process inputs and outputs, roles and responsibilities in a Responsible, Accountable, Consulted and Informed (RACI) chart, metrics and maturity model are provided for each process. Also, similar to COBIT, a set of policies, critical success factors (CSFs) and guidelines as control objectives for each process are defined. So, the control mechanisms are directed by control objectives of AUT SOA governance framework and focus on what is done in the process. We have defined more than 290 control objectives for processes of the framework that broadly specify related instruction works, activities and policies for each process. For example: Determining an enterprise data management function to define and monitor enforcement of data governance has been considered as a control objective for the Data Management process of the Service Operation domain.

C. Maturity Models

In transition to SOA, organizations need to assess where they are in the migration path to SOA and how to achieve greater benefits to support the organization, business and systems. In order to achieve SOA benefits associated with higher levels of maturity, AUT SOA governance framework provides a SOA adoption maturity model. SOA adoption maturity model is based on Open group Service Integration Maturity Model [19] and provides six dimensions across five maturity levels. The dimensions are Organization, Governance, Service and Service management, Architecture, Infrastructure and the Business View which are aligned with the framework specifications. Each dimension is divided into several domains and each domain has a set of possible capabilities and characteristics that point out the level of maturity of that domain. This model will be published with the framework. Moreover, a specific model is used for maturity assessment of each process. The process maturity model has been developed based on the generic qualitative model of COBIT which specifies principles of the attributes including Awareness and communication, Policies, plans and procedures, Tools and automation, Skills and expertise, Responsibility and accountability and Goal setting and measurement [15]. These attributes are the characteristics of process management and describe how they evolve from a non-existent to an optimized process.

IV. EVALUATION OF AUT SOA GOVERNANCE FRAMEWORK

To evaluate the proposed framework, we have used common techniques such as comparison with existing frameworks, qualitative evaluation, using the framework in some case studies and evaluation by public domain and practitioners.

We have selected to do an extensive case study at an IT department (Information & Communication Technology Department of Isfahan Municipality (ICTIM)) where we could model a part of the framework with a focus on analyzing business objectives, IT strategy, processes and capabilities of organization. This case study describes the application of the framework in an IT organization. Due to lack of space we will not discuss the obtained results. However, such a discussion will be published in the future papers. The results of comparison that has been made among AUT SOA governance framework and its counterparts have been presented in [20].

In this section, we present qualitative evaluation of the framework. We have used a qualitative model to examine the various aspects of AUT SOA governance framework. This model focuses on concepts and properties, findings, process and pragmatics. We have devised this model with a particular focus on the methods used most extensively in
evaluations and a review of existing frameworks for assessing quality in qualitative research[21],[22],[23] Table I presents the devised qualitative model to evaluate AUT SOA governance framework. For each criterion, we have identified relevant sub criteria with a comprehensive review of the literature [22], [23], [24], [25] on qualitative research methods elevating to standards in qualitative research and have matched them with the designed framework. Some of questions have been suggested for appraisal. The last column describes summary of our evaluation based on criteria.

**TABLE I. COMPARISON OF SOA GOVERNANCE FRAMEWORKS, COBIT AND THE PROPOSED FRAMEWORK**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub Criteria</th>
<th>Assessment questions</th>
<th>Description</th>
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<tbody>
<tr>
<td>Findings</td>
<td>Understandability</td>
<td>How findings have contributed to knowledge and understanding (e.g. of the framework, governance structures, process domains and related components)</td>
<td>AUT SOA framework is basically easy to understand and use. The framework elements are defined via a logical well-define structure that present some guidance to those who would like to understand it. The behavior of the framework is introduced via a conceptual model and a meta model which reduce overall complexity and help perceive the implications of proposed framework. So it becomes free from obscurity and easy to understand.</td>
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<tr>
<td>Concepts &amp; Properties</td>
<td>Contribution</td>
<td>Has the framework offered concrete guidance to researchers for future work?</td>
<td>AUT SOA framework is expandable across its main components. This research offers guidance for future action or for changing it for improvement and provides an interesting basis for future research. For example defining a set of control practices for each defined control objective the same as COBIT or applying the balanced scorecard (BSC) approach to evaluate performance of the processes are two future contributions of the framework.</td>
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<td></td>
<td>Expressiveness</td>
<td>How well is the framework architecture/structure? How well have the framework elements been defined?</td>
<td>The structure of the framework is presented explicitly. Also, the framework architecture is based on COBIT, ITIL and IBM which are well accepted. The governance structures, control mechanisms, processes, measurement metrics and all related elements within the framework have been presented explicitly and defined in details. Also, the framework elements and their relationships have been represented in a meta model by using UML notation that makes the framework more expressiveness</td>
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<td></td>
<td>Manageable</td>
<td>Does the framework determine control structures and mechanisms? How controls can be implemented within framework for all defined processes?</td>
<td>AUT SOA provides good practices across a domain and process framework and presents activities in a manageable and logical structure. They are strongly focused more on control, less on execution. By defining more than 290 control objectives for processes of the framework, the management requirements for effective control of each process have been broadly provided.</td>
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<td></td>
<td>Comprehensiveness</td>
<td>How well does the framework address SOA governance elements?</td>
<td>Based on the obtained results of the first evaluation (presented in [20]), all imperative SOA governance elements that existing frameworks do not completely cover them especially SOA roadmap, service lifecycle and evaluation processes have been considered in the proposed framework. So, it becomes a more comprehensive SOA governance framework which addresses SOA adoption requirements.</td>
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<tr>
<td>Process</td>
<td>Well-Documentation</td>
<td>Have all the framework components and their related elements been expressed clearly? How adequately has the framework elements been documented?</td>
<td>In the proposed framework all processes, their relationships, related roles and responsibilities, activities, activity goals and measurement metrics have been entirely documented and clarifies in a well-defined structure as processes management guidelines.</td>
</tr>
<tr>
<td>Pragmatics</td>
<td>Easy to use</td>
<td>Is the framework easy to use? Do the framework concepts and properties evolve easily?</td>
<td>From an empirical study of the framework, AUT SOA looks being simple to use. It provides an implementation scenario and layered steps.</td>
</tr>
<tr>
<td></td>
<td>Applicability</td>
<td>Does the framework adhere to the intended problem domain? Is the use of the framework suitable for a particular application domain?</td>
<td>The framework is based on COBIT that is a well-accepted and applicable framework that has been implemented by many companies. By applying logical structure, management and control mechanisms of COBIT, the proposed framework can be a credible and applicable framework.</td>
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<tr>
<td></td>
<td>Methodology Design</td>
<td>How defensible is the design process? Is methodology useful in creating new software, prototyping, or designing new model/framework?</td>
<td>The framework is designed by following the design science research methodology (DSRM) presented by Peffers et al. (Peffers et al., 2007) and using the guidelines for design science defined by Hevner et al. (Hevner et al., 2004). DSRM is used by many practitioners to design new artifact.</td>
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<td>Lifecycle coverage</td>
<td>Does design process involves all the development stages? How well does the process cover the whole lifecycle</td>
<td>The design process covers all stages of design the new framework. (Shown as figure 1). This process involves problem definition (Requirements gathering), define strategy (Analysis), design, demonstration (implementation) and evaluation (testing) within the development lifecycle.</td>
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</table>
developed a manageable, measurable and more expressive processes and governance structure, we have used a comprehensive framework that addresses evaluation aspects and control mechanisms of COBIT. Since COBIT is followed the design science methodology to develop a new related roles and responsibilities. Therefore, we have processes and their relationships, measurement metrics and existing frameworks have not completely documented all processes and their relationships, measurement metrics and related roles and responsibilities. Therefore, we have followed the design science methodology to develop a new SOA governance framework by leveraging the governance aspects and control mechanisms of COBIT. Since COBIT is a comprehensive framework that addresses evaluation processes and governance structure, we have used governance structure and main characteristics of COBIT and developed a manageable, measurable and more expressive SOA governance framework in which all processes descriptions, activity goals, control objectives, activities and metrics have been entirely documented as processes management guidelines. By considering SOA roadmap, service lifecycle and other important SOA governance elements in the proposed framework, it has been developed as a comprehensive SOA governance framework which addresses all SOA adoption requirements. This framework has been tested by analyzing with a qualitative model and addresses all SOA adoption requirements. This framework has been developed by considering SOA roadmap, service lifecycle and other important SOA governance elements in the proposed framework, it has been developed as a comprehensive SOA governance framework which addresses all SOA adoption requirements. This framework has been tested by analyzing with a qualitative model and applying it in a case study. However we suggest further case studies to monitor the application of our framework in multiple projects and its further verification in an iterative design cycle. As a future work, we will integrate the proposed framework and balanced scorecard (BSC) approach as a performance measurement system to establish objectives, metrics and a baseline for assessment of process maturity. It can be used as generic SOA governance balanced scorecard for improving SOA governance performance.

V. CONCLUSIONS

While there are several SOA governance frameworks to serve SOA implementation in organizations, they are deficient in coverage some important elements of SOA governance. For example, Service portfolio management and monitoring and evaluation processes are critical processes of a SOA governance framework that less attention has been made to them in the existing frameworks. Also, the existing frameworks have not completely documented all processes and their relationships, measurement metrics and related roles and responsibilities. Therefore, we have followed the design science methodology to develop a new SOA governance framework by leveraging the governance aspects and control mechanisms of COBIT. Since COBIT is a comprehensive framework that addresses evaluation processes and governance structure, we have used governance structure and main characteristics of COBIT and developed a manageable, measurable and more expressive SOA governance framework in which all processes descriptions, activity goals, control objectives, activities and metrics have been entirely documented as processes management guidelines. By considering SOA roadmap, service lifecycle and other important SOA governance elements in the proposed framework, it has been developed as a comprehensive SOA governance framework which addresses all SOA adoption requirements. This framework has been tested by analyzing with a qualitative model and applying it in a case study. However we suggest further case studies to monitor the application of our framework in multiple projects and its further verification in an iterative design cycle. As a future work, we will integrate the proposed framework and balanced scorecard (BSC) approach as a performance measurement system to establish objectives, metrics and a baseline for assessment of process maturity. It can be used as generic SOA governance balanced scorecard for improving SOA governance performance.

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