

Law Architecture for Regulatory-Compliant Public Enterprise Model: A Focus on Healthcare Reform in Egypt

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Abstract—Public business operations are governed by a set of legal sources, which regulate their implementation under administrative laws that are increasingly influencing software system design and development. Enterprise Architecture (EA) is a critical approach for driving business and Information Systems (IS) transformation in the public sector. On the other hand, EA frameworks lack representation schemas that support law models. Understanding of the law Architecture in the government domain is required for EA work and is thus the first architecture activity that must be completed. As EA approaches for Law compliance reviews are performed by legal experts, there is a gap between law experts and technical system architects. To cover these gaps, this paper proposes a novel framework for analyzing the administrative laws, extracting the legal policies and legal rules, identify their relationships with other EA domains, and identifying the law compliance requirements. Moreover, the integration of our proposed law architecture framework with existing EA frameworks to reach a law-compliant public enterprise model is identified. Finally, the applicability of the proposed framework is shown and validated through a case study. Moreover, subject matter experts of the legal domain also evaluated the extracted legal policies and rules during the implementation of our proposed framework.

Keywords—Law architecture; regulatory compliance; requirements engineering; enterprise architecture; law ontology; TOGAF

I. INTRODUCTION

Administrative laws are the law acts that regulate the operations of government agencies. The branch of law governs administrative agencies' development and operation. Administrative law, commonly known as (regulatory law), includes the rules and regulations that an administrative body promulgates and enforces. Administrative laws are compulsory for the institutional domain and are a benchmark for officials and architects in government and government digital transformation initiatives. Enterprise architecture (EA) is the method of aligning an authority's business with information technology, including the convergence of business procedures, Information Systems (IS), technology, and people[1]. EA has been in progress and deployment for the past years[2]. However, most authorities continue to have issues with EA practices; EA practice is not a simple task. Despite a large

number of current EA frameworks, public authorities have been unable to translate EA solutions to meet their needs [3].

In the study [1], the Gartner Group stated that a big percentage of EA implementations fail in the world because they start with modeling rather than defining business requirements first where the business requirements must meet the needs of IS. The business needs of the public agencies should comply with laws. Regulatory or law compliance management is a general concept that encompasses all practices and procedures used to ensure that a public authority adheres to all legal rules mandated by local or international laws. These laws are typically outlined in a natural language text that is difficult to comprehend for non-legal professionals. Existing laws pose a different set of problems. New digital transformation solutions may not be properly tested until they are put into operation and laws are developed to fix previous issues caused because of business and social shifts. To overcome the law compliance problem, several research studies have been conducted. Some researchers propose a law ontology approaches as a solution for law compliance. Some other researchers proposed regulatory compliance frameworks with the business process [4]. Moreover, other studies were conducted to regulatory compliance for requirements engineering [5] [6] [7] Enterprise architecture frameworks are used to guide the creation of enterprise models in terms of three domains namely business architecture, IS architecture, and technology architecture. Thus, extending the enterprise model to represent the policies identified by law can be obtained by defining the law architecture (our proposed framework) and integrating it with other enterprise architecture domains, as illustrated below in Fig. 1.

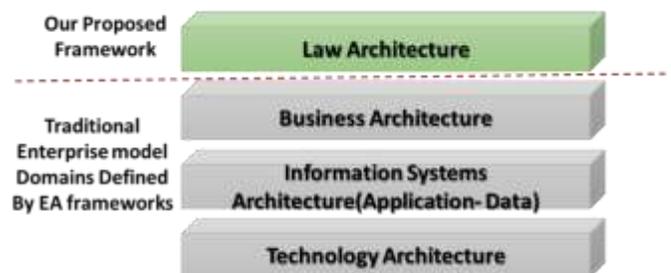


Fig. 1. Public Enterprise Model View after Integrating the Proposed Framework with EA Frameworks.

Knowledge of the law Architecture in the government domain is a prerequisite for architecture work. The law Architecture is also often necessary as a means of defining the governance layer and regulatory compliance requirements of following EA activities for all enterprise model domains.

Many emerging approaches to e-Government architecture, on the other hand, do not take legal sources into account. There is no formal structure for e-Government enterprise model enforcement with legal sources in these approaches. Compliance with regulatory issues and e-Government business models is a critical problem for governments. Thus, this study proposes a novel framework to address the following questions:

- How to manage compliance with laws across all enterprise model domains; business, IS, and Technology?
- How to design Government IS that complies with administrative laws?

- How to transfer laws policies into a machine-readable format?

In the next section, we present a state-of-the-art review of the related works. a detailed description for the proposed law architecture framework components and method including the integration with EA frameworks will be presented in Section III. Section IV presents the applicability of the proposed framework to real-life cases; the case study of the Egyptian Universal Health Insurance program is demonstrated. Finally, in Section V, a brief analysis of the obtained conclusions and future work are discussed.

II. STATE OF THE ART

Law compliance or regulatory compliance is a concept of acting in accordance with established laws, regulations, etc. In order to judge that a public authority is following the given legal rules or not, compliance auditing is conducted.

TABLE I. COMPARISON OF SURVEYED STATE-OF-THE-ART OF REGULATORY COMPLIANCE

Study		Extraction of legal rules	Ontology representation	Integration with enterprise model	Meta-model	Requirements engineering for SW	Legal modeling
Business process compliance	Jörg Becker,2015 [1]	√				√	√
	Christina Stratigaki ,2016 [2]	√			√		√
	Noel Peter,2017 [3]	√					
	Selja Seppala ,2017 [4]	√	√				√
	Hashmi Mustafa,2018 [5]	√					√
	Cesare Bartolini ,2019 [6]	√	√		√	√	√
	Raimundas M. , 2020 [7]	√			√		
	Tobias Seyffarth, 2021 [8]				√	√	
Law Ontology	Mirna El Ghosh,2017 [9]	√	√				
	Monica Palmirani,2018 [10]		√		√		√
	Galina Kurcheeva,2019 [11]	√	√		√		
	Valentina Leone, 2020 [12]	√	√				
Requirements Engineering	Ftemeh Zarrabi,2015 [13]		√		√	√	
	Ana Zalazar,2017 [14]					√	
	Sushant Agarwal,2018 [15]	√			√	√	
	Mahmood Alsaadi,2019 [16]	√				√	
	Michael Felderer,2020 [17]					√	
The proposed framework		√	√	√	√	√	√

A compliance review is an important activity of compliance auditing which depends on the extraction of regulatory compliance requirement from administrative laws. There have been an increasing number of research challenges to automate regulatory requirements extraction from legal acts.

Administrative laws, which drive the development of regulatory compliance solutions, are generally available as natural language text documents (semi-structured format), and understanding them is performed by legal domain expertise. Testing a given business model for enforcement is, unsurprisingly, a manual process performed by accredited domain experts. Moreover, effective regulatory compliance requires good knowledge of the enterprise model of public authority by the legal auditors and a good knowledge of the compliance framework by the enterprise architects. This makes the close collaboration of legal auditors with enterprise architects a necessity. The challenge of automated compliance checking can be seen as extending an enterprise model to include concepts defined by the regulatory compliance framework and enabling the needed automation in checking an enterprise model against the policies defined in a regulatory compliance framework.

This is because most legal acts are written in natural language, which a conventional computer system cannot understand. A legal ontology is a theory that describes the concepts that exist in the legal acts and how they are connected. Many kinds of research have been undertaken to develop ontological representations for legal documents to achieve law compliance [8] [9] [10] [11]. On other hand, a big number of studies exist for achieving law compliance through linking laws policies with Business Process Models (BPM) [12] [13] [14] [15] [16] [17] [18] [19]. Moreover, Regulatory compliance is a well-studied area in software requirements engineering, including research on how to model, check, analyze, extract, and validate compliance of software different requirements engineering techniques for achieving software compliance as discussed in [20] [21] [22] [23] [24] the below Table I outlines the comparison between different approaches for achieving regulatory compliance. Based on the comparison Table I, we argue that this literature survey could not find any contribution that addresses the topic of how to integrate law compliance solutions with the enterprise model.

III. PROPOSED FRAMEWORK

The proposed Law Architecture Framework (LAF) provides the baseline for mapping various legal policies related to regulatory requirements to business process, stakeholders, capabilities, IS, data concepts, and technology architecture. Regulatory compliance planning and subsequent deployment projects require mapping and tracking the evolution of the following artifacts of law architecture:

- Legal policies tied to business capabilities.
- Legal rules tied to business processes.
- Legal policies and rules tied to data concepts.
- Legal policies and rules tied to Information systems.
- Legal policies and rules tied to Technology.

The law architecture framework is a goal-oriented, law-driven framework aimed to define compliance requirements through which a particular public enterprise and its related information systems can comply with a given administrative law. We define the law architecture as a holistic representation, multidimensional views of legal policies and their derived legal rules, and identifying their relationships with the business, data, information systems, and technology domains, in addition to identifying the requirements of compliance with these rules and policies. Law architecture requires a complete framework to guide its development and practice. We argue that the effort required to accomplish the law architecture activities should be performed by a team that has both bits of knowledge of technology and law domains, a team with the following key roles:

- Law Architect is an information and communications technology professional that is responsible for analyzing administrative laws and extracting from them the regulatory compliance requirements of business, IS, and technology architectures. The law architect must be reasonably knowledgeable of the administrative laws and public sector domains to be familiar with public sector services and the operational environment.
- Legal Counsel: According to the BIZBOK Guide [25]" A Legal Counsel is a person who is legally qualified and licensed to represent an organization in a legal matter, such as lawsuits, policy formations, contract negotiation, and patent activities". A legal counsel regularly works in legal departments of the public authorities and is considered the subject matter expert during the law architecture cycle. The legal council is responsible for the analysis, and validation of extracted policies and rules. The objectives of the law architecture framework can be summarized as follows:
 - To align laws and regulations with business and IT Systems.
 - To identify and model legal policies and rules and linking them with the enterprise model domains namely; business architecture, information systems, and technology architecture.
 - To identify the relationship between legal rules and other architecture domains.
 - To identify the regulatory compliance criteria with the legal rules.
 - To manage any suggested law amendments and assess their impact on the enterprise model.
 - To develop the appropriate viewpoints, models, and matrixes that enable the demonstration of how the legal policies are addressed in the business, IS, and technology architectures.

As shown in Fig. 2, the law architecture framework consists of the following components:

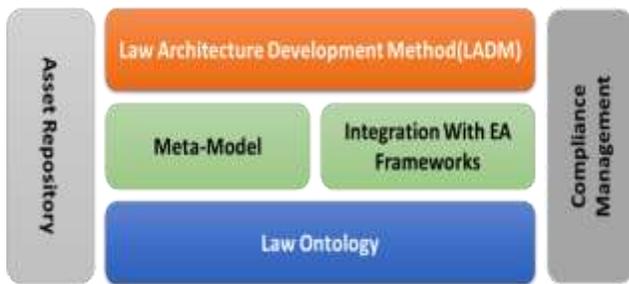


Fig. 2. Components of the Proposed Law Architecture Framework.

- Law-Architecture-Development-Method (LADM): describes a set of guidelines and activities for developing a law Architecture.
- Law Architecture Meta-model: defines a formal structure of core concepts and their relationships to ensure consistency within the law architecture.
- Asset Repository: outlines different taxonomies and guidelines to categorize and store the inputs and outputs of law-architecture effort such as laws catalogs.
- EA framework integration: describes the ability to integrate the law architecture framework with other enterprise architecture frameworks.
- Law Ontology: defines an ontological and semantic representation of the law architecture Meta-model for getting a machine-understandable model that is enabled easily for automation and model analysis.
- Regulatory Compliance Management: defines different approaches for checking a public enterprise model against the legal policies and rules defined within the LADM.

The details of some selected components of the proposed framework are detailed as follow:

A. Law-Architecture-Development-Method (LADM)

The LADM is the product of the continuous efforts of law architects and legal counsels. It describes a method for modeling and managing the compliance requirements of laws that govern the public enterprise and forms the core of the Law architecture framework. It describes the steps, guidelines, and tools to analyze, extract, and model the legal policies and rules from administrative laws. Moreover, it guides the definition of the correlation between extracted legal policies and rules with other public enterprise model domains, to align the public authority and its IT systems with the law.

Fig. 3 depicts the phases of the proposed LADM which consists of the following:

- Law Architecture Initiation.
- Phase (A): legal Policy Mapping.
- Phase (B): Legal Rule Mapping.
- Phase (C): Definition of legal Policies/ Business architecture correlation.

- Phase (D): Definition of legal Policies / IS architecture correlation.
- Phase (E): Definition of Legal Policies / Technology architecture correlation.
- Management of Suggested Law amendments.

The level of detail addressed in Law Architecture will depend on the scope and objectives of the overall law-architecture effort. The key steps in details of the LADM include the following:

1) *Law architecture initiation*: The Objectives of this phase include initiating the law Architecture Capability planned by the public authority, defining the law Architecture Principles, and Identifying the set of administrative laws that applies to the business performed by a public organization which is related to the IT systems' Scope. The LADM is a generic approach that can be used by a broad range of public bodies and, if necessary, in combination with a wide range of EA frameworks. The recommended steps within the initiation phase are as follows:

a) *Determine the Scope of the Public Agency Impacted*: Identify the public entity core units that would be most affected or gain the most benefit from the law architecture work.

b) *Define and Establish the Law Architecture Team*: The required team members that will develop the law architecture should be identified.

c) *Define Law Architecture Principles*: A principle is an agreed-upon fact that can guide one's analysis and reasoning. Core principles that apply to law architecture, in general, are:



Fig. 3. Law-Architecture-Development-Method (LADM) Phases.

- Legal policies are accessible and shared.
- Common Vocabulary and legal policy Definitions.
- Law architecture's scope is defined by a set of laws applied to the public authority.
- The law architecture process is iterative.
- Law architecture artifacts are reusable especially those extracted from domain-specific laws.

d) *Develop Law Catalogs*: Catalogs form the raw legal documents for the development of models and views and represent a key artifact for driving the law architecture activities. The following catalogs should be developed:

- Project-Related Acts Catalog.
- Domain-Related Acts Catalog.
- Legal Policy catalog.
- Suggested Amendments Catalog.
- Ontology Representation.
- Suggested Amendments Catalog.
- Regulatory Compliance Requirements.
- Approved Amendments Catalog.
- Suggested Amendments Catalog.
- Compliance Requirements Catalog.

2) *Phase (A) Perform legal policy mapping*: The objectives of this phase are analyzing architecture scope impacted acts and extract the legal policies representations, Reviewing extracted policies with different legal experts and ensuring their correctness and consistency, and finally updating the legal policy catalog. Administrative laws define the legal limits for public authority by enforcing requirements that specify which actions are legal and which must be prohibited during the conduct of daily operations. A legal policy is a statement or set of statements that describe the course of events and how a specific action should be carried out. A policy is defined to achieves a business goal. A legal policy has a subject, who is the stakeholder(s) who is/are responsible for carrying out the policy's actions. A legal policy requires a business capability to be executed, a business capability is defined as a set of resources and activities that integrate to deliver a value to an internal or external stakeholder (target). Legal Policy mapping is the core of law architecture and an excellent starting point. Describe the policies and legal rules associated with the law articles, the main idea in the law architecture is that legal policies define decisions on whether a state of the business activity is allowed or not. The extraction of legal policies and rules is a hardworking and time-consuming activity and is recommended to be carried out by legal architects (or business analysts) with the help of legal counsels. To extract the legal policies the architects must look for important information by

scanning the legal articles and try to answer the following questions:

- Why was the article written? The answer to this question identifies the objectives that the policy intends to achieve.
- What rules/actions intended by the policy? And what are the required capabilities required to achieve these rules?
- Who responsible for executing these rules/actions and who will be affected by them?
- When are these rules/actions allowed to be performed?
- Where these rules/actions are applicable? By answering when and where questions the event and scope of the legal policy can be identified.

A legal Policy can be classified as follow:

a) *Business Function*: Identified by article(s) that defines a course of business activities that should be performed in a predefined manner to achieve some business outcomes.

b) *Organization Unit*: Mapped by an article(s) that define an organizational structure and responsibilities.

c) *Technical Function*: Mapped by an article(s) that directly describe an IT resource or system.

Legal Policy Mapping Approaches include the following:

a) *Top-Down Approach*: The top-down approach to policy mapping is performed by scanning and analyzing the administrative law starting from the first article until the last article. For each article try to answer the five whys' questions listed above to extract the Legal policies essential to regulate the operation and services provided by the public enterprise.

b) *Goal-Oriented Approach*: the legal councils identify the main objectives of each administrative law, and for each goal, the team scans the law and extracts the related policies.

3) *Phase (B) Perform legal rules mapping*: The objectives of this phase are analyzing legal policies and laws then extract the intended legal rule, reviewing and validating extracted legal rules with different legal experts and ensuring their correctness and consistency, and finally, update the legal rule catalog. To perform legal rule mapping properly the following concepts should be considered:

- A legal rule is derived from one or many legal policies, in other words, many legal rules can be sequentially implemented to achieve a certain legal policy. A legal rule is also has a business goal and has a scope. A legal rule requires input data to process and has an input event that triggers the execution of the legal rule.
- A legal rule contains an action that is implemented in a business process usually in a form of a business decision.
- A constraint is an assertion that, by one of its properties or a relationship to another concept, such as as a role in

an activity, restricts or reduces the potential representation for a concept. For example, the statement “a beneficiary who under-poverty-line” constrains the set of all possible beneficiaries to the possibly smaller set of only those beneficiaries who are under the poverty line.

- A stakeholder is an entity afforded rights and/or obligations by the law.
- A right refers to one or more actions that deliver a defined stakeholder a certain value or benefit. If a stakeholder is not obligated to perform an action or to receive an action value, called an anti-obligation.
- An obligation refers to one or more actions that are required to be undertaken by a certain stakeholder.
- An anti-right refers to one or more actions that are not permitted to be performed by a certain stakeholder.
- A rule’s action is either a right, obligation or anti-right per our above definitions.

4) *Phase (C) Identify the correlation between extracted policies and business architecture:* Legal policies represent the governance layer that organizes the business functions, therefore linking legal policies with their related capabilities, processes, organization units, and stakeholder will simplify the alignment of these business objects with laws and will result in a law-compliant Information system when these business artifacts mapped to IS. In other words, will help the administrative entity to deliver the right service to the right citizen at the right time. Moreover, will enhance the efficiency and transparency of the public institutions. The correlation between legal policies and business architecture can be illustrated through the analysis of the legal policies catalog and developing the following matrixes:

- Legal policy Mapping to Business Capabilities describes.
- Legal Rule Mapping to Business Process.
- Legal policy Mapping to Organization Structure.
- Legal Rule Mapping to Stakeholder.

5) *Phase (D) Identify the correlation between extracted policies and Information Systems(IS) architecture:* Information systems designed to support business processes in public authorities must conform to the relevant legal acts and regulations. The correlations between business architecture and legal policies should be transferred into technical system requirements and IS should be designed to comply with these requirements. IS architecture is consists of data architecture and application architecture. After identifying the business regulatory compliance requirements through phase (C), the following steps should be performed in this phase to design, a law-compliant IS in a later detailed IS architecture definition cycle using any EA frameworks. Typical dimensions of the

correlations between extracted legal policies and IS architecture include the following:

a) *Define Data Concepts:*

- Extract data concepts from the legal rules.
- Extract the data modalities from the constrains.
- Classify the data concepts (internal or external).

b) *Define Role/Application Function Matrix:*

- Each participant stakeholder with the legal rules should be mapped to an application role.
- Each action assigned to a legal rule should be mapped to an application function.

c) *Define Application Interaction Matrix:*

- Stakeholders and data concepts defined in the legal rule catalog should be classified into internal or external (of the scope of the public authority).
- Each external concept defines a possible integration requirement with external systems.

6) *Phase (E) Identify the correlation between extracted policies and technology architecture:* Technology Architecture consists of software and hardware assets that are used to implement and realize information system solutions, legal policies, and rules that have a direct impact on technology architecture. The correlation between legal policies and technology architecture can be identified as follow:

a) *Availability of the Systems:* Based on the scope and type of services identified by legal policies the availability of the systems can be identified for example the availability of health services should be 24/7, the technology services should grantee the operation of the systems 24 Hours in 7 days each week. The availability of some other public services mandated by law could be only within the official working hours or for a certain time like examination systems or submission of tax declaration requests.

b) *Data Archiving and Retention Plans:* Data retention refers to the storage of transaction data for a certain time. The primary objective in government data retention is traffic analysis and judicial arbitration. Each country has its data retention policies and plans that are defined in its administrative laws.

c) *Network and Communications:* Based application interaction matrix defined in phase D, the requirement of communication lines between the public authority and external entities should be identified, the detailed specifications of these lines can be identified later in the detailed technology architecture cycle of EA practice. The scope of the legal policy also can identify the locations where the required IS should be accessed, thus also implies communication lines requirements.

d) *Security Requirements:* The access rights for data assets can be defined based on the Roles/ application function matrix developed in Phase C.

7) *Phase (F) Collect and communicate the suggested law amendments:* The object of proposing new law amendments is to improve the effectiveness, efficiency, and fairness of the administrative processes. Architecture practice implemented in Law, business, data, IS and technology phases may propose new procedures designed to afford more time for this function. It is hoped that delays and costs will be reduced and that new prestige will be provided for those who make the decisions. Suggested Law amendments should be handled as follow:

- a) Build the Suggested amendments Catalog.
- b) Update the Catalog with any suggested law amendments during architecture phases (Law, Business, data, IS, and Technology).
- c) Prioritize Law amendments and assess their impact.
- d) Communicate the amendments to the relevant Stakeholders.

B. Law Architecture Meta-Model

In the previous section, a method to create and manage the law architecture artifacts within the government enterprise was defined. At each step, a discussion of architectural work and artifacts was presented such as the legal policy map and legal rule map. The content Meta-model provided here defines a formal structure for the core concepts of the law architecture and their relationships to ensure consistency within the law architecture and to guide the implementation of the law architecture within a public enterprise. Fig. 4 depicts the proposed law architecture Meta-model.

C. Integrating Law Architecture with EA Frameworks

In the context of digital transformation in the public sector, the integration between law architecture and EA frameworks is a natural architectural alignment of two related disciplines. Law architecture represents the mapping of legal policies and rules related to IT architecture while EA provides a guiding framework for business and IT architecture alignment. According to the Federation of Enterprise Architecture Professional Organizations, EA “represents the holistic planning, analysis, design, and implementation for the development and execution of strategy by applying principles and practices to guide organizations through the integration and interoperation of all other architecture domains”[26]. Most EA approaches do agree on the foundational domains, which include:

- Business Architecture.
- Information Systems (Application- Data) Architecture.
- Technical Architecture.

For each architectural domain, there is an associated set of Law related concerns, each set can be described by law architecture models that define the legal rules governing that domain. Integrating Law architecture with EA offers the following benefits:

- Brings a robust, Law-centric focus to the practice of EA in the public sector.
- Integrates all aspects of law compliance through all layers of the IT solution.
- Facilitates the adoption and implementation of new law amendments in public enterprises.

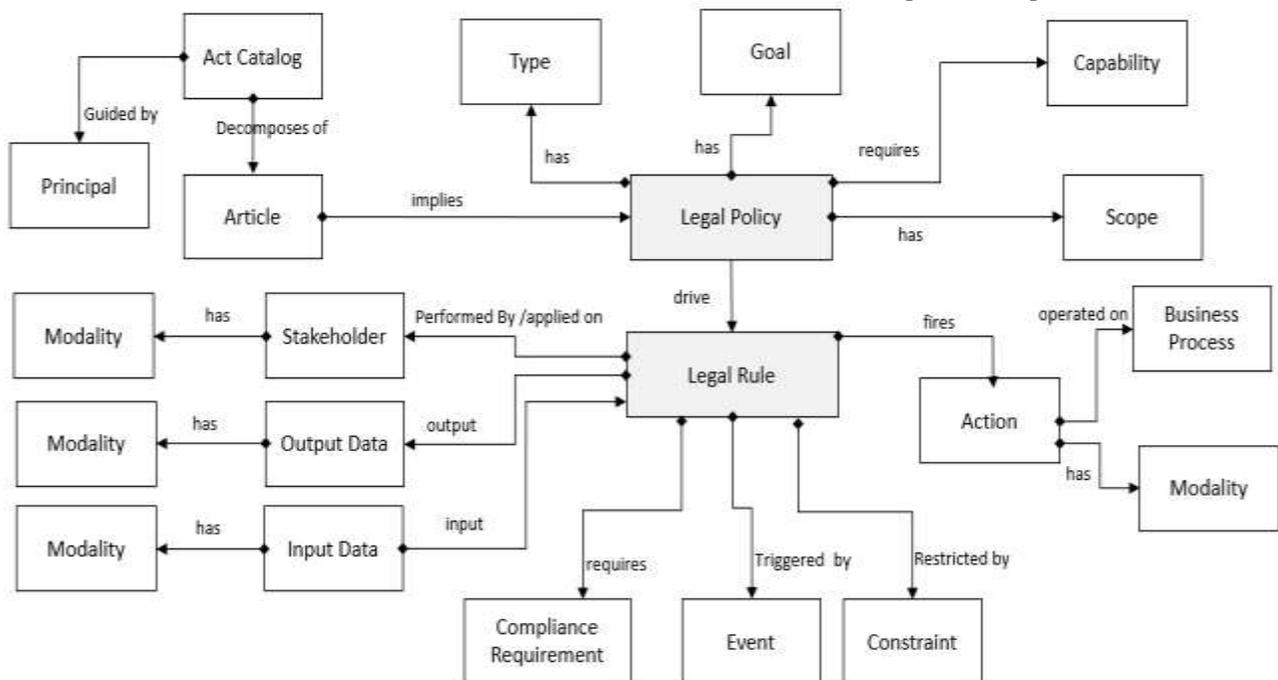


Fig. 4. Law Architecture Meta-Model.

TOGAF [27] is an architecture framework. TOGAF that is widely used by many EA practitioners within the public sector was selected here to demonstrate the capability of our proposed framework to integrate with EA frameworks. At the core of the TOGAF framework is the architecture development method (ADM) that “provides the methods and tools for assisting in the acceptance, production, use, and maintenance of enterprise architecture. It is based on an iterative process model supported by best practices and a re-usable set of existing architecture assets” [20]. The proposed Law Architecture Framework (LAF) here, has a Law-architecture-development-method (LADM) that provides the methods for assisting in the production and maintenance of law architecture. The ADM of the TOGAF can be adapted to integrate with the LADM of our proposed LAF.

Fig. 5 depicts the ADM in a larger form and Fig. 6 illustrates how TOGAF ADM can be integrated with LADM. The Suggested ADM Adaptation to be integrated with the proposed LADM can be listed as follow:

- 1) After the architecture vision (Phase A) of the ADM: Then the LADM should be initiated and completed according to the detailed description listed above.
- 2) After the end of the LADM: Then the TOGAF Business architecture phase should be performed.
- 3) The result from LADM Phase (A): Should be added as an input to the TOGAF Business architecture phase.
- 4) One of the objectives of the TOGAF business architecture phase is to develop the target business architecture, the target business architecture may have any suggested business process engineering that is based on some law amendments suggestions, these amendments should be linked with LADM Phase (F), Collect and Communicate the suggested Law amendments .
- 5) After the completion of the TOGAF business architecture phase, the information systems architecture phase should be initiated by adding the result from the LADM phase (D) to the inputs of that phase of the ADM.
- 6) One of the objectives of the TOGAF IS architecture phase is to develop the target IS architecture, the target IS architecture may have any suggested IS improvements is based on some law amendments suggestions, these amendments should be linked with LADM Phase (F).
- 7) After the completion of the TOGAF IS architecture phase, the technology architecture phase should be initiated by adding the result from LADM Phase (E) to the inputs of the phase.
- 8) Any suggested technology improvements that require some law amendments suggestions, should be linked with LADM Phase (F)
- 9) The TOGAF ADM phases will be completed then as defined in TOGAF Standard.

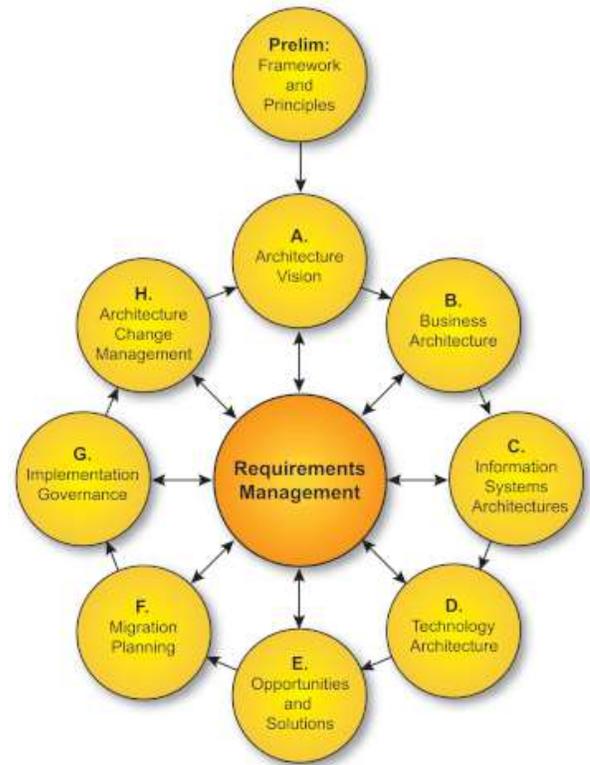


Fig. 5. ADM Process of the TOGAF Framework.

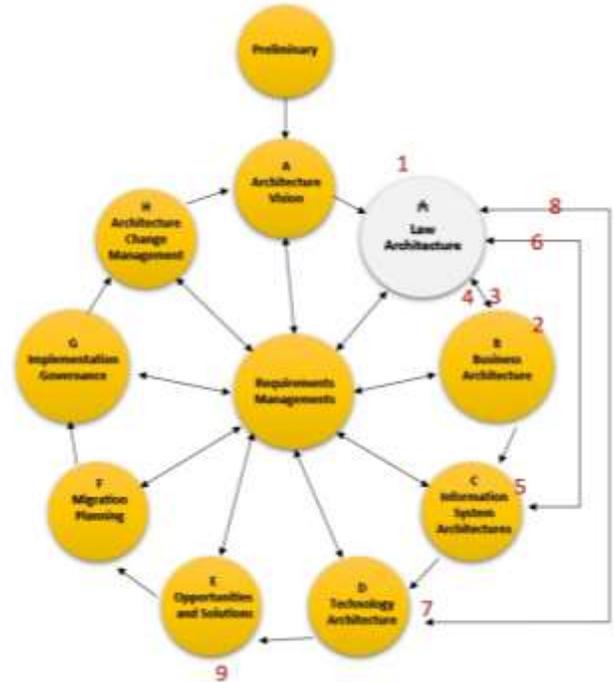


Fig. 6. Adapting the TOGAF ADM to Integrate with LADM.

IV. HEALTHCARE REFORM IN EGYPT THROUGH THE LENS OF THE LAW ARCHITECTURE: A CASE STUDY

TABLE II. UHI PROJECT-SPECIFIC ACTS CATALOG

A. Universal Health Insurance (UHI) Law at a Glance

The Egyptian Parliament endorsed a fresh law on universal health coverage that was formally promulgated on January 11, 2018, by the President. The Universal Health Insurance Law (2/2018) is regarded as an unprecedented effort to control the healthcare industry in Egypt, expanding the extensive protection of healthcare to every industry of culture. Healthcare was dealt with on a case-by-case ground before this law. The 27 governorates of Egypt will be split into six regional fields when applying the fresh law, and the law will then be implemented gradually over the next 15 years. Existing laws and regulations in the health insurance sector will stay in effect during the transformation era. Subscription to the new health insurance scheme will be compulsory for all Egyptians living in the Arab Republic of Egypt and free for Egyptians employed or remaining onboard with their relatives. Fees are laid by revenue and extra financing sources to include tariffs on the tobacco industry and other extra regions. The state has dedicated to offering the strategy to about 25 percent of the population who are unable to afford it free of cost.

B. Defining the UHI Law Architecture based on the LADM

The Ministry of Health has formed a technical committee including representatives from the Ministry of Communications and Information Technology (MCIT), the Ministry of Finance, and a consortium of experienced international and local experts. The mandate of this committee was to explore how to realize the objectives of the UHI law, study each use case defined in the law, and define the technical specification of the required systems. As the corresponding author of this manuscript was one of the enterprise architecture team assigned by MCIT to achieve the technical design and architecture of the required systems. The architecture team depended on analyzing the UHI law as the prime source of information in identifying the high-level system requirements. By following the steps and guidelines of the LADM proposed above and illustrated in Fig. 2, the team analyzed the UHI available laws and identified the law architecture of the UHI program before performing a detailed enterprise architecture activity, the extracted law architecture models resulted from this exercise can be illustrated as follow:

1) *Law architecture initiation*: During this phase, the law architecture work will follow the principles identified in section (III), and Table II represents the Project-Specific Acts Catalog that stores the core administrative laws related to the UHI project.

2) *Phase (A) Perform legal policy mapping*: The UHI law was analyzed, and 10 legal policies and 23 related legal rules were extracted as shown in Table III. To understand the main elements in the legal policy and their relationships to each other the legal policy model was suggested. For example, article (41) identified three important legal policies as shown in Fig. 7.

#	Act No.	Subject	Issuing Date	Issuing Authority
1	No.2 of 2018	The universal health insurance system law	Jan. 2008	The Parliament
2	Bylaw- No.909 of 2018	The executive regulations of the universal health insurance system law promulgated by law No. 2 of 2018	May.2008	The Prime Minister
3	No.707 of 2018	Setting criteria for targeting those below the poverty line in applying the provisions of the Universal Health Insurance Law	April 2018	The Prime Minister
4	No.2257 of 2020	Devolution of some medical assets in the governorates of Port Said and Luxor to the Public Health Care Authority in preparation for their inclusion in the Universal health insurance system	Nov. 2020	The Prime Minister
5	No.2273 of 2020	Determinants of patients with chronic diseases and tumors and controls for their exemption from Universal health insurance premiums	Nov. 2020	The Prime Minister

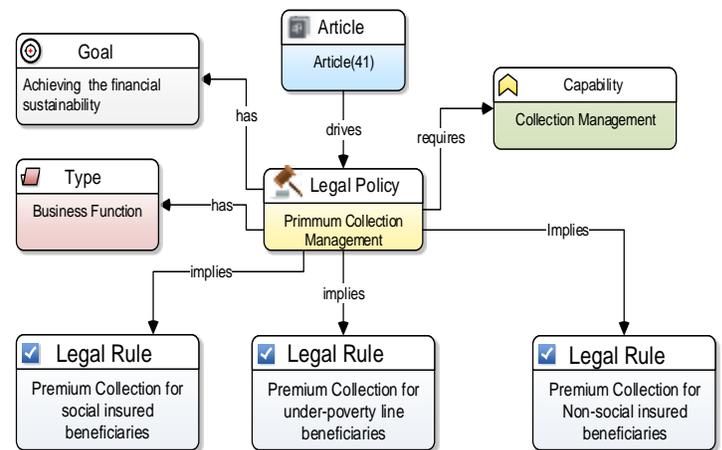


Fig. 7. Model of Premium Collection Management Policy.

3) *Phase (B) Perform legal rule mapping*: The legal policy catalog listed below in Table III was analyzed versus the UHI law to extract and model the related legal rules, Fig. 8 represents a sample legal rule model that represents “Premium Collection for Social Insured Beneficiaries”. Each extracted legal rule was modeled to provide a visualized artifact that can be easily understood by different business and IT stakeholders.

TABLE III. LEGAL POLICY CATALOG OF THE UHI PROJECT

Policy ID	Policy Name	Type	Ref. Article	Req. capability	Goal	Legal Rules
LP_01	Premium Collection Management	Business Function	41	Collection Management	Collection of Financial resources required to achieve financial sustainability	<ul style="list-style-type: none"> Premium Collection for social insured beneficiaries Premium Collection for under-poverty line beneficiaries Premium Collection for Non-social insured beneficiaries
LP_02	Premium calculation	Business Function	41	Collection Management	Collection of Financial resources required to achieve financial sustainability	<ul style="list-style-type: none"> Premium calculation for public employees Premium calculation for private-sector employees Premium calculation for Self Employed Premium calculation for pensioner premium calculation for pension entitled premium calculation for beneficiaries under the poverty line
LP_03	Board of Directors structure of UHI authority	organization structure	5	Program Management	Defining the structure and responsibility of the authority management	<ul style="list-style-type: none"> UHI authority board of directors Duration of the board
LP_05	Disability injuries policy	Business Function	13	Beneficiary management	Defining the process of issuing a disability certificate	<ul style="list-style-type: none"> disability certificate issuing responsibility disability certificate notification responsibility
LP_06	Co-payment policy	Business Function	table (3)	<ul style="list-style-type: none"> Health Service Management Collection Management 	Define the beneficiaries' contributions for health services	<ul style="list-style-type: none"> co-payment value for home visits co-payment value for medicine co-payment value for scans co-payment value for medical tests co-payment value for inpatient services
LP_07	Military recruits handling policy		53	Beneficiary management	Managing the services for the military people	<ul style="list-style-type: none"> Military recruits handling procedures
LP_08	UHI website and Database	Technical Function	57 - bylaw	IT Management	Building a website and DB for UHI Authority	<ul style="list-style-type: none"> building a website and defining access rights
LP_09	National Social Insurance Authority responsibility	Technical Function	57 - bylaw	IT Management	Feeding the authority's database with the necessary data for all those subject to the registered social insurance laws and their families.	<ul style="list-style-type: none"> feeding the authority's database with social insured people and their families
LP_10	work injuries policy	Business Function	12	Beneficiary Management	Regulate the work injury treatment process	<ul style="list-style-type: none"> work injury notification procedures work injury treatment

TABLE IV. LEGAL POLICY / CAPABILITIES MATRIX

Policy Name	Business capability
Premium Collection Management	Collection Management
Premium calculation	Collection Management
Board of Directors structure of UHI authority	Program Management
Disability injuries policy	Beneficiary management
Co-payment policy	Service Management
Military recruits handling policy	Beneficiary Management
UHI website and Database	IT Management
National Social Insurance Authority responsibility	IT Management

1) Phase (C) identify the correlation between legal policies business architecture:

a) *Develop legal Policy/Capabilities Matrix:* Table IV. depicts legal policy/capabilities matrix.

b) *Legal Rule/Business Process Matrix:* Table V depicts legal rule/business process matrix.

TABLE V. LEGAL RULE / BUSINESS PROCESS MATRIX

Legal Rule	Business Process
Premium Collection for social insured beneficiaries	Manage accounts receivable Funds
disability certificate issuing responsibility	Authorize Medical Service
co-payment value for home visits	Manage Rate setting
Military recruits handling procedures	Manage Treatment plan
Feeding the authority's database with social insured people and their families	Manage Integration with external entities
work injury notification procedures	Manage Treatment plan

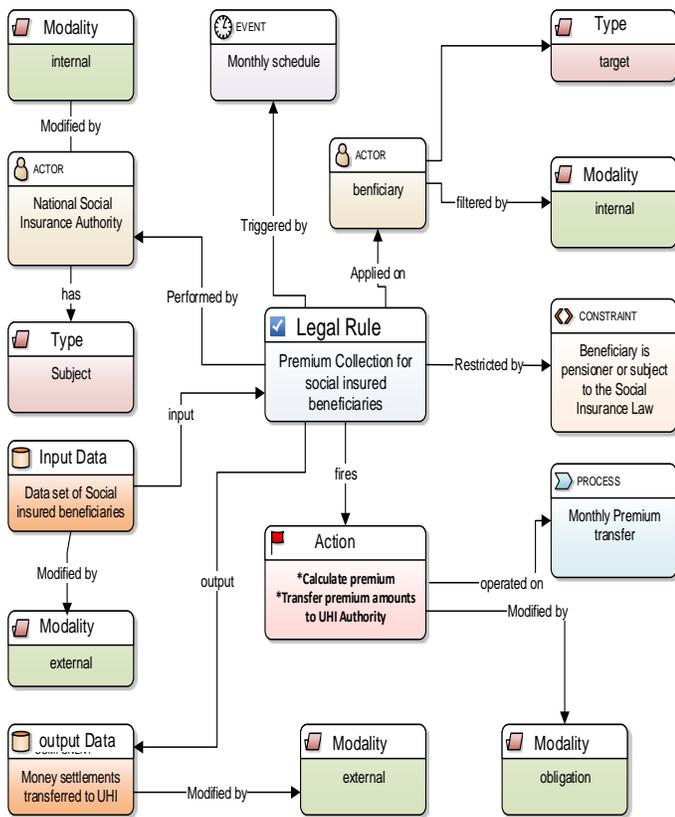


Fig. 8. Legal Rule Mode: Premium Collection for Social Insured Beneficiaries.

c) Stakeholder Mapping: By analyzing the legal policy and rules catalogs several system use cases can be identified in terms of obligations and rights as illustrated in the below Fig. 9.

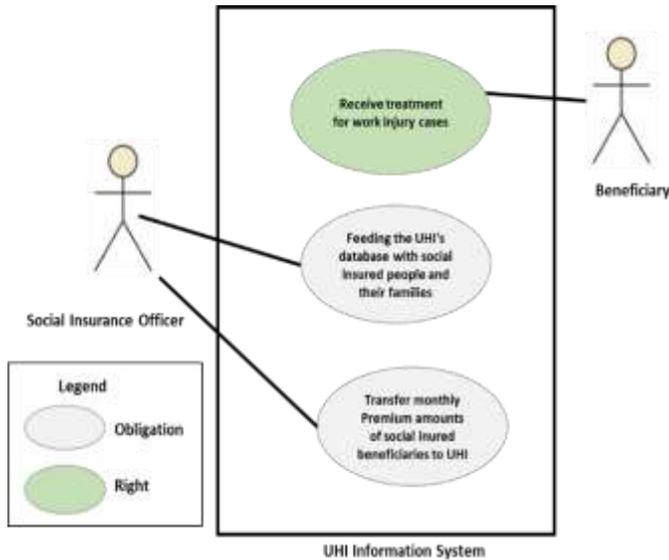


Fig. 9. A Legal Use Case Diagram of the UHI Project.

2) Phase (D) Legal Policy/Information systems Correlation:

a) Data Concepts Extracted from the Law: By analyzing the legal policy and rules catalogs the data concept catalog that is related to the IS was created, the most important data concept related to our extracted above policies is the beneficiary, and by analyzing the legal rule's actions and constraints we deduced that the beneficiary data should be segmented based on the following features shown in Fig. 10.

b) Application Interaction Matrix: By classifying the data concepts as internal or external to the UHI authority, the external data concepts define an integration requirement. Moreover, analyzing the actions related to the legal rules can also identify integration requirements. Following these procedures, the following integration requirements were identified as below in Fig. 11 and Table VI:

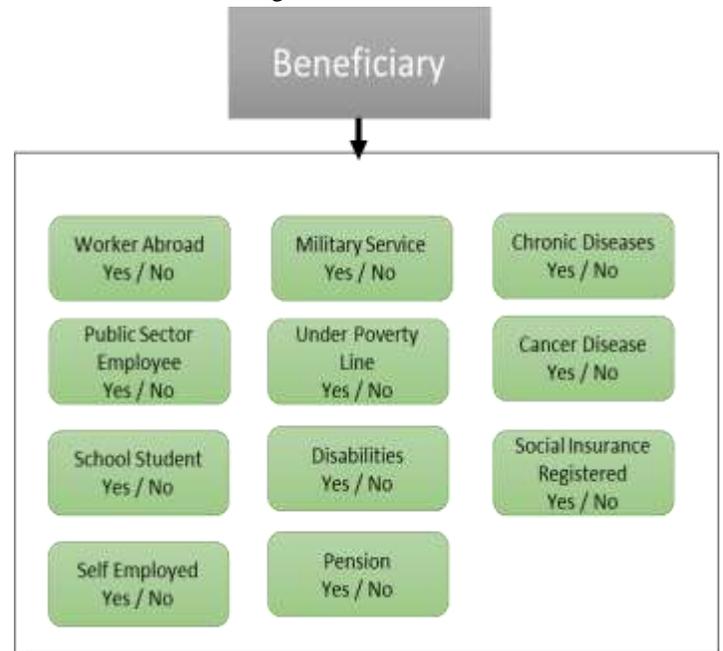


Fig. 10. Beneficiary Segmentation Features.

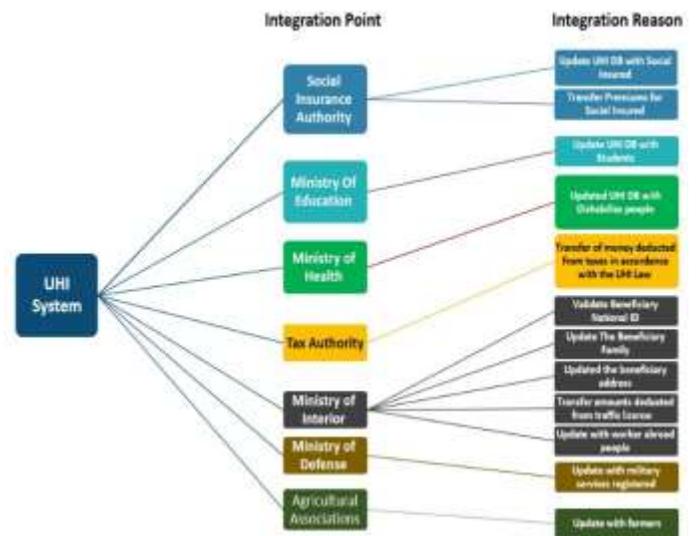


Fig. 11. Application Interaction Diagram.

TABLE VI. APPLICATION INTERACTION MATRIX

#	Target System (External Systems)	Integration Reasons
1	Social Insurance Authority	<ul style="list-style-type: none">• Update UHI DB with Social Insured• Transfer Premiums for Social Insured
2	Ministry of Education	<ul style="list-style-type: none">• Update UHI DB with Students
3	Ministry of Health	<ul style="list-style-type: none">• Updated UHI DB with Dishabilles people
4	Tax Authority	<ul style="list-style-type: none">• Transfer of money deducted from taxes under the UHI Law
5	Ministry of Interior	<ul style="list-style-type: none">• Validate Beneficiary National ID• Update the Beneficiary Family• Updated the beneficiary address• Transfer amounts deducted from traffic license• Update with worker abroad people
6	Ministry of Defense	<ul style="list-style-type: none">• Update with military services registered
7	Agricultural Associations	<ul style="list-style-type: none">• Update UHI system with farmers and their families
8	Ministry of Social Solidarity	<ul style="list-style-type: none">• Update UHI System with under-poverty-line people and their families

3) Phase (E) Legal Policy / Technology architecture correlation: The following technology requirements were extracted based on the legal policy catalog and the regulatory compliance requirements catalog was updated as following Table VII:

TABLE VII. SAMPLE OF REGULATORY REQUIRMENTS CATALOG

#	Requirement	Type	Rational	Architecture Domain
1	The system and servers should operate at 24/7 uptime.	availability	The system provides healthcare services	Technology
2	all changes to a financial database must be recorded in a trace file with before and after values	Audit Tracing	Enable financial transactions tracing	Technology
3	All communications between the UHI system and Social Insurance System	Communication	Respond to system integration requirements	Technology
4	Keep a record of all transactions for 5 years	Data Retention	Mandated by law	Technology

V. DISCUSSION

As presented above, in the introduced case study, the UHI law was the prime source of information that the technical committee depended on for extracting the high-level specifications of the digital transformation solution required for the UHI program. EA frameworks lack a detailed methodology for analyzing and modeling laws, thus our proposed law architecture framework suits these types of problems where the

core business processes and services are highly regulated by laws. The law architecture framework offers the ability to visualize what decoupling and divesting laws and how it impacts various aspects of the public ecosystem. This was illustrated through the use case as the legal policies and rules were extracted from the UHI law, in addition to the relationship between these rules and business capabilities, processes, IS, data concepts, and technical specifications based on the proposed LADM that represents the heart of the proposed law architecture framework. The application of the proposed framework supported the UHI program in extracting the regulatory compliance requirements from the law and supported the design of regulatory-compliant system.

Law architecture does not stand alone in a public enterprise. Several complementary or ancillary frameworks or disciplines may exist within a public enterprise. Each of these frameworks may have its focus. The success and maturity of law architecture are influenced by its ability to integrate and align with each of these disciplines and frameworks. Another limitation in our proposed framework is the LADM proposed for extracting the legal rules and policies and their correlations with other artifacts in the public enterprise model is a manual task. This is because ambiguity exists in the laws that require the investigation and validation of legal experts.

VI. CONCLUSIONS

In recent years, there have been various contributions to deal with law compliance problem, None of the previously surveyed work in the state of the art section takes an (i) generic approach to law compliance management, (ii) seeks to integrate with EA frameworks, (iii) allows declarative modeling of policies and rules while separating these two concepts and, (iv) introduces a new concept and formal definition for the law architecture and, (v) supports for traceability by a set of links to establish between legal policies and enterprise models. Our claim through this work is that our proposed framework allows for achieving these goals and overcomes these limitations:

- Domain-independence: a solution to the problem of IS requirements engineering to comply with all applicable administrative laws.
- Domain-variability: a solution that takes into account the variability of possible legal policies and rules applied in different public sector services.
- Flexible-integration: a solution that takes into consideration the integration with other EA frameworks to achieve a law-compliant public enterprise model.
- Machine-readable: a solution that can be easily translated into an ontology model.
- Knowledge-gap: a solution that covers the knowledge gap between the technical architects and the legal experts.

Finally, the applicability of our proposed framework is shown and validated through a case study. Subject matter experts of the legal domain also evaluated the extracted legal policies and rules during the implementation of the case study.

VII. FUTURE WORK

In this paper, we did not cover all components of the proposed law architecture framework, future work will include a detailed description of other framework components such as compliance management and ontology representation of the framework metamodel. Moreover, the capability of our framework to integrate with other EA frameworks will be investigated.

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