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Towards a Regulator-Oriented Regulatory Intelligence Framework

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***Abstract*—With regulations influencing almost all societal interactions, divergent views about their relevance and performance exist today. In consideration of the time and cost implication involved in complying, regulated parties often complain of overregulation. Governments, motivated to ensure the safety, security and prosperity of their communities, insist on effective and efficient regulations and advocate for more. Additionally, citizens and interest groups advocate for more or fewer regulations depending on perceived benefits to them. This scenario puts pressure on regulators mandated to administer regulations. They are required to be transparent and accountable in showing the performance of regulations while accommodating the concerns of different stakeholders involved. In this regard, this doctoral research proposes a framework that regulators can use to show the performance of their regulations through modeling and measuring regulations and evaluating and reporting their outcomes. The Regulator-Oriented Regulatory Intelligence Framework (RORIF) adopts a regulatory intelligence approach that involves the use of data and takes advantage of the capabilities of existing Business Intelligence and analytical tools.**

***Index Terms*—Regulatory Compliance, Lean-Design Science Research, Maturity Model, Goal-Oriented Modeling**

I. Motivation

Almost every societal interaction is influenced by a regulation. The motivation for their introduction is to ensure the safety, security and prosperity of communities. Although regulations aim to control or change behaviors to achieve outcomes, the perception is that they are reactive rather than preemptive. Examples include the Dodd-Frank Wall Street Reform and Consumer Protection Act introduced after the financial crisis of the late 2000s [1] or changes to the "Railway Safety Act" and "Canada Transportation Act" after the 2013 Lac-Mégantic explosion [2]. Responses of governments aiming to prevent the reoccurrence of crises with new or evolved regulations suggest society is under-regulated. This leads to scenarios of over-regulation. It is not uncommon to see multiple regulations or regulators regulating the same issues, often with overlaps [3].

While regulations are considered beneficial to society, they can also be viewed as burdensome by the regulated parties required to comply with them [4]. In addition to the assumptions of over-regulation, there is the frequency of changes in regulations[5]. Also, in consideration of the time and cost implication involved in ensuring compliance, complains of over regulations is common among regulated parties [6]. Furthermore, based on perceived benefits of regulations, the position of citizens and interest groups such as lobbyists and watchdog organizations, swing between overregulation or under-regulation [4]. These concerns of under-regulation and over-regulation put the spotlight on regulators who are mandated to administer regulations.

Regulators have to show the performance of regulations, i.e., that they are *effective* (producing the desired or intended results), and *efficient* (their benefits exceed the cost involved in administering them). Regulators are also required to show this performance while being transparent and accountable, and accommodating the concerns of different stakeholders involved [9]. Activities involved in regulators carrying out their mandate include making regulations, setting objectives and expected results, implementing and enforcing the regulations, and reviewing and revising them to see how they perform. While regulators do well in addressing most of these activities, they appear to fail in activities such as reviewing regulations. These activities also called *ex-post* activities are needed to show the performance of regulations [10]. Reasons for this include too much focus on attaching economic values to the benefits of regulations [7][10], regulators not knowing what to measure [10] [11], a lack of understanding of data requirements [8] and the existence of disparate information management systems in the regulatory process.

Showing that regulations are effective and efficient is of utmost interest to regulators today [7][8]. Measuring the progress of regulations throughout the regulatory process has been the topic of various studies. Common examples include studies that use artificial intelligence (AI) and requirements engineering (RE). In these domains, researchers explore the use of software and information systems (IS) to facilitate regulatory compliance through confirming compliance and evaluating the issues related to non-compliance. In this respect, software and IS serve as the foundation for research on compliance. The rationale is that if they can improve operational function in organizations, they can also help in measuring compliance [12]. The research focus, however, has been on enabling *regulated* parties to comply with regulations rather than on enabling *regulators* to enforce compliance. For example, a recent literature review on methods used in regulatory compliance within requirements engineering indicates that only 18% of reviewed articles addressed the concerns of regulators [13].

This doctoral research focuses on the *ex-post* activities of regulators. In this context, it proposes a framework, named the *Regulator-Oriented Regulatory Intelligence Framework* (RORIF), which regulators can use to assess and improve the performance of their regulations. RORIF consists of two mod-

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els and a method guiding their use. It enables utilizing evidence and analytical insights obtained from data for implementing, evaluating and reviewing regulations and their impact. RORIF builds upon existing work on the use of the User Requirement Notation's "Goal-oriented Requirement Language" (GRL) [14] for the goal-oriented modelling of regulatory compliance. In addition, it exploits design principles based on maturity models in IS research [15].

II. The State of the Art

Definitions of regulatory intelligence (RI) centers on the act of gathering and analyzing regulatory information from various sources (laws, regulations, regulators, competitors etc.) towards supporting decision-making [17]. While RI has often been presented from the viewpoint of regulated parties, in recent years, it has been extended to include the viewpoint of regulators [16]. Herein, information obtained from compliance reports and feedback from the regulated parties can be used in improving compliance enforcement as well as in evolving regulations. Taking advantage of business intelligence (BI) and analytical tools, regulators can exploit RI to enhance the regulatory process. Regulators can use data to support decision making towards the implementation, evaluation and review of regulations. Such an RI approach should be able to identify and address challenges regulators face in utilizing the information they obtain throughout the regulatory process. To arrive at such an RI approach, an understanding of how regulators administer or show the performance of regulations becomes necessary. This is to enable a recognition of what works and what could be improved upon. To achieve this, I reviewed the existing literature in the regulatory compliance domain using a systematic literature review methodology. Along with a description of the state of the domain, the results of these literature reviews identified two problem areas that serve as further motivation for this doctoral research.

The use of software and IS to better facilitate regulatory compliance from the viewpoint of regulators was the focus of the systematic literature review of 1207 articles done in [18]. The study explored how regulators monitor and manage regulatory compliance. Here monitoring regulatory compliance implies getting insights on the state of compliance at certain points in time (daily, monthly, annually, etc.). Managing regulatory compliance implies getting insights on the state of compliance at certain instances within a compliance process (when compliance is done, when a violation occurs, etc.). The result showed a paucity of empirical research on how regulators address compliance despite advances in the use of software and IS to better facilitate compliance. Identified in this review were frameworks used by regulators to test hypotheses on how compliance to regulations leads to favorable or unfavourable outcomes. The majority of these frameworks were conceptual. They tested the effectiveness and efficiencies of regulations when they monitored (and not managed) regulatory compliance.

Problem Area 1: *The results of this review indicate a paucity of empirical research on how regulators monitor and manage regulatory compliance and the challenges they face in doing so. With regulators as custodians of the regulatory ecosystem, they determine who complies or not. A focus on their needs will address concerns of perceived ambiguity in regulations, under- or over-regulation, and ways of addressing the evolution of regulations*.

Within artificial intelligence (AI) and requirements engineering (RE) research on this topic, goal-oriented modelling and non-goal-oriented modelling methods are used. The former type is based on the use of goals and their relationships to structure requirements according to the way they contribute towards achieving goals of various stakeholders. The latter type is based on methods such as natural language-based techniques (e.g., semantic annotations) or logic-based programming techniques. These methods do not use goal modelling. A systematic literature review of 83 articles where these methods have been used was done in [13]. The review explored their main benefits and drawbacks. The results reveal that goal-oriented modelling methods appear to offer more benefits for all compliance tasks in comparison to non-goal oriented modeling methods. In addition, the results show that both types of methods have been used more in the healthcare domain with 58% of articles reviewed targeting it. As for contexts, which present compliance concerns that need addressing, of the 18 contexts identified, privacy was the most often addressed with 58% of the instances reviewed. A total of 45 different laws from ten different countries were involved in the reviewed articles, with 69% focusing on privacy. Finally, while 82% of the articles reviewed addressed concerns of regulated parties, only 12% addressed the concerns of regulators alone, and 6% addressed concerns of both regulating and regulated parties together.

Problem Area 2: *These results suggest that more emphasis is required on compliance concerns of regulators in order to enable them to enforce compliance and assess regulations more effectively. Also, a wider variety of domains (besides healthcare) and contexts (besides privacy) should be addressed to further explore and quantify existing and new benefits and drawbacks of both types of methods*.

The state of the art indicates a paucity of empirical research on how regulators administer and enforce compliance or show the performance of regulations. Regulations are often introduced or evolved without serious evaluations to support them [10][19]. With increasing emphasis on evaluations based on empirical evidence to decide on the performance of regulations, an RI approach will likely prove useful.

III. Research Questions and Objectives

Conceptually, to show the performance of a regulation, evaluations are needed of substantive outcomes of the regulation and any relevant process-oriented outcomes based on administrative, democratic or technocratic values [10]. Herein, substantive outcomes are *technocratic*, such as referring to how effective the regulation is in solving the problem it was designed for, and *economic*, such as referring to the cost-effectiveness of the regulation. Process-oriented outcomes are based on *administrative* values such as how long it takes to implement a regulation. They are also based on *democratic* values such as the number of public participants involved in the

regulatory decision-making process as well as *technocratic* values [10]. In practice, obtaining data to do this appears almost unrealistic.

This doctoral research proposes another approach to showing regulatory performance, i.e., an evaluation that compares actual compliance with a regulation and the desired objective of the regulation. This approach relies on the RI approach, using compliance reports and feedback from the regulated parties. Measurements can be obtained on compliance and assessed to see if compliance objectives are met and how they relate to the objective of the regulation. Assessments using these data can be done to determine if compliance goals are exceeded or not in relation to the desired outcome. This could suggest a potential need to improve or change the regulation. Assessments can also determine if a regulation is effective or efficient. This allows for further analysis such as areas of the regulation complied with the most or least, who complies, and what they comply with. Furthermore, such an evaluation would prove useful in determining what regulators' practices contribute positively or negatively to achieving these evaluations. This will inform on regulators' proficiencies; their abilities or aptitude, in line with proven practices.

To develop an approach that can facilitate a comparison of actual compliance level of a regulation and the desired objectives of the regulation, certain challenges need to be considered. First, we need to identify how compliance can be enforced and assessed in the regulatory process. What activities or tasks are involved? Secondly, we need to assess regulators relative proficiencies that are based on their practices that can enable them to obtain analytical insight from data from these tasks towards enforcing compliance. Finally, we need to integrate these methods into a comprehensive approach for deriving respective qualitative and quantitative conclusions on regulatory performance. Such an approach distinguishes between knowledge and practical problems [20][21], two mutually nested problems common within design science research (DSR).

A knowledge problem indicates a difference between what we know about the world and what we would like to know while a practical problem (also referred to as a design problem) consists of a difference between the way the world is and the way we think it should be [20]. While practical problems require a change in the world so it better agrees with some stakeholders' goals, knowledge problems require a change in our knowledge about the world where the problems exist [21]. Research problems are knowledge problems; they can be solved by asking others, searching the literature or doing research. Here we search for propositions empirically proven to be true to the respective laws in the problem environment. To solve a practical problem, we utilize criteria specific to the stakeholder whose problems we seek to address.

Accordingly, in this work, I distinguish between knowledge problems (KP) and design problems (DP), and define research questions to guide this research. They are:

1) *Research Question 1 (KP):* What tasks are involved in enforcing compliance to a regulation? Are existing software or IS really suitable for use by these tasks to assess compliance enforcement?

2) Research Question 2 (KP): What are the practices of regulators involved in the regulatory process? What will offer a form and function based on these practices that could enable regulators to assess their relative proficiency in showing the outcomes of regulations using data towards enforcing compliance?

3) *Research Question 3 (DP):* How can we measure, assess and improve the interactions between i) compliance tasks involved in enforcing regulatory compliance, and ii) regulators' proficiency derived from their practices in order to show regulatory performance?

Based on these research questions, I define three objectives described below and illustrated in Fig. 1.

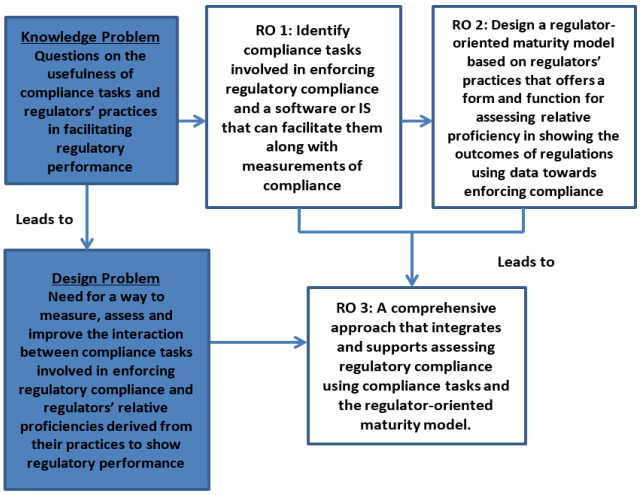

Fig. 1. Relationship Between the Knowledge and Design Problems and their Relationships to the Research Objectives

1) Identify compliance tasks involved in enforcing regulatory compliance and a software or IS that can facilitate them along with assessments to show compliance levels.

2) Design a regulator-oriented maturity model based on regulators' practices that offer a form and function for assessing relative proficiencies in showing the outcomes of regulations using data towards enforcing compliance.

3) Develop a comprehensive approach that integrates and supports compliance level assessments based on compliance tasks and the regulator-oriented maturity model. This approach should also support maturity improvements that regulators can adopt to better reflect proven practices.

Therefore, the goal of this doctoral research is to introduce a comprehensive approach that regulators can use to exploit evidence and analytical insights obtained from data in the implementation, evaluation and review of their regulations. This comprehensive approach, the *Regulator-Oriented Regulatory Intelligence Framework (RORIF)*, can also be used to assess and improve their performance in line with proven practices.

IV. Research Approach

This doctoral research will follow a lean approach to Design Science Research (DSR) [22]. DSR does not follow a descriptive or prescriptive approach to problem-solving common

to other research methodologies. It attempts to create innovative artifacts that solve problems in a formalized manner [23]. To achieve this, DSR proposes that knowledge and understanding of a problem domain and its solution are achieved in building and applying the designed artifact. While DSR focuses on the output of the research process (the artifact which solves the stakeholder's problem), the outcome of the research process (the value obtained) is often overlooked. At the core of the lean approach is the emphasis to systematically minimize waste and create value [24]. A lean approach to DSR influences the research process to build upon the core principles of lean development; continuous delivery of the solution to solve stakeholders' problems. Therefore, using the lean approach, the research process is done in collaboration with the stakeholder and the learning obtained in iteration is applied towards arriving at the appropriate solution. This is akin to the lean loop [25] and bears similarities with the engineering cycle, a logical structure for solving practical problems [21].

Here, the implementation evaluation and problem investigation activities of the engineering cycle correspond to the "build" activity of the lean loop with the investigation of the current situation. This agrees with my investigation of the current state of the regulatory compliance domain as described in Section II. Likewise, the solution specification activity corresponds to the resulting "product" of the leap loop and agrees with the proposed RORIF described in Section V. The specification validation activity corresponds to the "measure" of the lean loop with investigations of the proposed solution properties leading to qualitative and quantitative measures validating a selection. This agrees with my proposed validation and verification of the proof-of-concept version of RORIF with qualitative and quantitative evidence as described in Section VI. Finally, the specification implementation corresponds to the "learn" stage of the lean loop with an assessment of the new situation as a result of the introduced solution. This agrees with my proposed evaluation strategy described in Section VI.

The lean approach to DSR will guide my use of the DSR methodology research activities to focus on the outcome of the research process. The activities of this research will be (1) *problem analysis* (described in Section II), (2) *solution design* (described in Section V) and, (3) *solution implementation, validation, verification, and evaluation* (described in Section VI).

V. RORIF Description

Activities carried out to ensure adherence to laws and regulations using software or IS are called compliance tasks. They include compliance *modelling*, *checking*, *analysis* and *enactment* tasks [12]. As described in Section II, goal-oriented modeling methods offer more benefits in comparison to non-goal-oriented modelling for all these compliance tasks. As such, RORIF builds upon existing work on the use of GRL [14] for goal-oriented modelling of regulatory compliance. In addition, RORIF exploits design principles based on maturity models in IS research [15], to offer a maturity model based on regulator's practices. The maturity model shows a regulator's relative proficiencies in obtaining analytical insight form data towards enforcing compliance. These regulators' practices clearly distinguish between policy priorities and objectives (responsibilities of elected governments) and regulatory decisions that should contribute to achieving these objectives (responsibility of the regulator) [9].

Therefore, RORIF is comprised of two models and a method that serve as guidelines for its use. They are:

- The *Goal-oriented Requirements Intelligence Profile (GORIP)* a GRL profile that includes elements of Legal GRL [25][27], a GRL profile to extract legal requirements from single or multiple regulations. It also includes elements of the Goal-Oriented Pattern Family Framework [28], a systematic step for eliciting requirements from regulations leading to the creation of patterns and families of goal models. It also includes elements of the Indicator-based Policy Compliance Framework (IPCF) [29], a GRL profile that uses *key performance indicators (KPI)* to measure compliance levels. Finally, it includes elements of Dynamics of Goal Models [30], a new approach to enhance goal model analysis by including analysis across multiple time scales.
- The *Regulator-oriented Maturity Model (ROMM):* The ROMM will be descriptive, enabling as-is assessments of regulator proficiencies that suggest at what level they are in obtaining analytical insight from data towards enforcing compliance. It will also be prescriptive, indicating what is needed to be at higher proficiency levels, without skipping necessary steps. ROMM will be based on proven practices that aim to describe the roles and functions of a regulator that is accountable and transparent [9]. The proficiency will be indicated by a sequence of maturity levels graduating from low to high levels.
- The proposed method of RORIF will serve as a guideline on how to use the framework and its models to make qualitative and quantitative conclusions on regulatory performance. It is proposed to include three iterative steps: *assess*, *identify* and *evolve*. In the Assess step, an evaluation that compares the actual compliance level and the desired objective of a regulation is done to show the performance of the regulation. In the Identify step, an assessment of the regulator's relative proficiency in its use of data that results in an evaluation of the actual compliance level and performance of the regulation is obtained. Finally, in the Evolve step, based on the regulator's relative proficiency, explorations can be done on what is required for the next logical maturity level attainable.

To demonstrate the application of RORIF, consider a regulator interested in showing the performance of the HIPAA "privacy of individually identifiable health information" regulation [31]. This regulation's objective is to ensure consent on behalf of patients or children is made by an authorized person. In the Assess step, using GORIP, a model of the regulation is made. To aid analyses of actual compliance levels, using indicators in the goal model, compliance data (obtained from compliance inspections or self-regulation results) are fed into the model. The objective of the regulation is also modeled. This allows

the regulator to reason about the actual compliance level and compare with the desired objective. This analysis is facilitated by the analytical capabilities of the GORIP elements.

The GORIP evaluation results can be imported to databases and BI and analytical tools used to enhance further analysis. Analysis can be along different dimensions of time, location, organization, regulation structure, etc. to answer different performance-related questions defined by the regulator. In the Identify step, the maturity level of the regulator that enabled arriving at the actual compliance level and performance of the regulation based on its access and use of data is identified. This is a measure of the relative proficiency of the regulator. Finally, in the Evolve step, based on the regulator's relative proficiency, the regulator is aware of what worked and what did not. The regulator is also aware of what improvements need to be made about the regulation in line with proven practices. This is represented as the next logical attainable maturity level.

VI. Validation, Verification and Evaluation

To ensure that RORIF meets the defined objectives described in Section III, I intend to validate, verify and evaluate it in real-life instances involving regulators addressing *ex-post* activities to show the performance of regulations. In line with the Lean Iteration Meta-Pattern [22], the validation and verification will ensure that RORIF performs as expected and is coherent in enabling qualitative and quantitative conclusions on the performance of regulations. During the development of RORIF, a validation will be done in iteration towards a proof-of-concept version. Using interviews with open-ended questions on a target group of practitioners amongst regulators serving as key informants [32], RORIF will be checked to get qualitative evidence. Afterwards, the proof-of-concept version will be verified using a survey on a larger group of practitioners among regulators for quantitative evidence. The final version of RORIF will then be implemented and validated in real-life instances involving a few partner regulators. A further verification will then be done with a survey of regulators who used RORIF. Finally, results of the two sets of validation and verification will help evaluate RORIF's ability to show the performance of regulations and its practical and knowledge contributions shown using the design science research methodology (DSRM) [34].

As with any research process, I expect to face threats to the validity of this work. These threats can influence the design, implementation, and evaluation of RORIF [35]. They include construct validity, which reflects whether the constructs (performance of regulations, and the maturity level of regulators) that I propose to measure is indeed measured. To mitigate this, I intend to observe and measure how well RORIF enables regulators to exploit evidence and analytical insights obtained from their data towards the implementation, evaluation and review of regulations. Another threat is internal validity. This reflects the extent to which observed causal relationships exist within the data I will obtain from the research, particularly if proposed inferences about them will be valid. To mitigate this, I intend to collect and evaluate data from two groups of regulators (which signify multiple views) across different regulatory domains [32]. They will represent a smaller group of key informants and a larger group of practitioners among regulators. Another threat is external validity, which reflects the extent to which I can generalize the results outside the scope of my selected study or a broader population. To mitigate this, the *lean approach* to DSR [22] provides opportunities to validate RORIF qualitatively and then verify quantitatively. I will do this at two levels, first at the design stage and when I implement. Here I will be using a case-based generalization strategy for software engineering theories [32]. Finally, there is conclusion validity. It reflects the extent to which RORIF is relevant in showing the performance of regulations and the relative proficiency of regulators in obtaining analytical insight from data towards enforcing compliance. To mitigate this threat, I have used two systematic literature reviews to bring to bear challenges regulators face in enforcing compliance as described in Section II. Subsequently, I intend to work in a real-life scenarios involving regulators.

VII. Author's Contributions and Publications

This doctoral research has covered several topics in the regulatory compliance domain. Its primary contribution is a description of the current state of research in the domain (Section II), conference proceedings [12] and journal articles [13] [18]. This can serve as a motivation and guidance for further research in this domain, particularly from the viewpoint of regulators. This research has also introduced the lean approach to DSR [22] and provided additional guidance for researchers within the RE community who use DSR [34].

Future anticipated contributions of this doctoral research can be categorized as contributions to practice and knowledge. Contributions to practice refer to benefits to the regulators. This includes an empirical research on the performance of regulations that regulators can utilize and refer to. Also is a method to determine actual compliance levels of regulations and their comparisons with the desired objective of the regulation using the GORIP. Another is a method regulators' can use to assess their proficiencies in line with proven practices using the ROMM. Contributions to practice refer to benefits to the scientific body of knowledge. In this regard, contributions include additional validations of the concept of RI in addition to work by Badreddin et al. [16]. Also is additional validation of the use of the goal modelling method (i.e. the GRL) for regulatory compliance from the viewpoint of regulators with the GORIP and the use of the GORIP for goal model analysis using time as a variable. Finally, is the validation of design principles based on maturity models in IS research [15] for the ROMM.

VIII. Description of Progress

At the moment, this doctoral research has focused on exploring and scoping out challenges in the regulatory compliance domain. This has identified problem areas that motivate RORIF to address the concerns of regulators. The next steps will involve working with key informants (practitioners in the regulatory domain), to observe challenges they face in showing the performance of regulations. This is geared towards the de-

sign, implementation and evaluation of RORIF to enable regulators show the performance of regulations while accommodating the concerns of different stakeholders.

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