

What can Information Systems do for Regulators?

A Review of the State-of-Practice in Canada

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Abstract—Regulations constitute a rich source of requirements for software systems, especially so for information systems that handle sensitive data. However, there has been little attention paid to regulators and their requirements for managing the regulatory lifecycle. This paper presents a study of the state-of-practice for regulators in Canada by examining seven Government of Canada (GoC) agencies responsible for regulations. In each case, we attempt to capture the context within which regulations are created, the motivation behind these regulations, and the practices related to their design, enforcement, and review. Our aims are to understand how regulators currently design, monitor, and assess regulations and other regulatory instruments in their respective domains, and to identify opportunities where information system (IS) solutions can be applied to improve practice. Our field study involved reviewing publicly available information and conducting informal interviews. Together, these activities helped us understand key regulators' activities and concerns, as well as important challenges they currently face. In this paper, we summarize our findings and explain the implications for the use of ISs to improve the practice of regulatory management in the form of a research agenda.

Keywords— Regulation, Regulator, Regulatory Ecosystem, Information Systems, Research Agenda

I. INTRODUCTION

Regulations constitute a rich source of requirements for software systems, especially information systems (ISs) handling sensitive information. However, little is known about how information systems could serve useful roles in designing, managing, and enforcing regulations. This is partly due to a general lack of knowledge about the concerns and challenges regulators face and how ISs might be used to address them. Instead, there has been much more emphasis on using ISs for regulated parties. For example, IS can be used to help clarify laws and regulations, differentiate between requirements that are feasible or not, and establish compliance with laws and regulations through analysis and mapping interrelationships [1]. A recent systematic literature review highlights the paucity of IS research focusing on regulators [2]. In fact, only 18% of existing research on the use of ISs to address regulatory compliance actually addressed concerns of regulators [3].

The regulatory ecosystem is an interconnected network of governments, regulated parties, citizens, interest groups, and regulators, formed through social and legal interactions. Governments enact laws through legislations that ensure the safety, security, and prosperity of citizens and their communities.

Regulators are mandated either independently or with oversight by governments to administer these laws (also called Acts or Statutes) using regulatory instruments such as regulations, performance agreements, standards, and codes of practice. Regulatory instruments are tools, such as incentive programs, used to change or modify behavior to meet the objectives of each legislation [4]. While regulated parties are required to comply with these regulatory instruments, interest groups such as lobbyists or watchdog organizations try to influence their introduction, evolution, or repeal.

Despite the many stakeholders involved in the regulatory system, almost all crises resulting from perceived regulatory failures have been blamed on regulators. This, in turn, means that regulators are always under scrutiny. Consequently, regulators are required to carry out the functions of their mandate and address the challenges they encounter in the process, in an effective, transparent, objective and impartial manner, without conflict of interest, bias, or improper influence [5]. Different principles and guidelines have been proposed by bodies such as the Organization for Economic Co-operation and Development (OECD) and by the European Union (EU), on how regulators should better align their activities in carrying out their mandate. For example, the OECD's *Best Practice Principles for Regulatory Policy: The Governance of Regulators* was introduced to enable assessment and review of current regulatory structures and how to make them more effective, accountable, and transparent [6]. Also, the EU's *Better Regulations Guidelines* are a set of guidelines offered to ensure that policies and laws are designed so that they achieve their objectives at minimum cost [7]. In addition, the OECD's *Best Practice Principles for Regulatory Enforcement and Inspections* provide a basis for effective and efficient regulatory enforcement and inspection [8].

Given the complex work required by regulators and the paucity of research on how and where IS can help, this paper focuses on how regulators can leverage software technologies to help facilitate achieving their mandates. Our aim is to identify concerns and challenges encountered by regulators in carrying out their regulatory functions that can be addressed by ISs.

II. REGULATORY TERMINOLOGY

The terminology used by regulators connotes meanings that may not be applicable in other domains. We first define the basic terminology used in the practice of regulators to enable a better understanding of the regulatory ecosystem:

- *Regulation*: a type of regulatory instrument backed by penalties, intended specifically to modify the behavior of regulated parties. An example is the “Food and Drug Regulations” (C.R.C., c. 870) [9]. This particular regulation prescribes the standards of compositions, strength, potency, purity, quality, or other property of the article of food or drug to which they refer.
- *Prescriptive Regulation*: here, how compliance should be achieved is defined in the regulation, leaving regulated parties little or no choice regarding how to comply. There often are yes/no assessments that check adherence to regulatory requirements. An example is the “Canada Oil and Gas Installations Regulations” (SOR/96-118) [10], which outlines requirements for design of installation safety features.
- *Outcome-based Regulation*: the required outcome of the regulation or level of performance is written into the regulation, without necessarily prescribing how to achieve its objectives. Compliance assessment measures the levels at which the objectives are achieved. An example is the “Motor Vehicle Safety Regulations” (C.R.C., c. 1038) [11], which specifies design, construction, performance, and durability requirements for motor vehicles and regulated automobile safety-related components, systems, and design features.
- *Policy*: course, principle, or action adopted or proposed by a government about enhancing the life of citizens or improving communities and businesses. An example is the “Policy on Access to Information” [12], which provides directions to Canadian government institutions for effectively and consistently administering the Access to Information Act and Regulations.
- *Objective*: the government’s intention behind a legislation; the purpose for which legislation is required and how regulatory solutions will be evaluated for effectiveness. An example is the “Feed Regulatory Renewal Consolidated Modernized Framework Proposal” of November 2015 [13].
- *Outcome*: refers to what is ultimately achieved by an activity, as distinct from its outputs that relate to more direct or immediate objectives. An example is the “Descriptors for Government of Canada Outcome Areas” [14].
- *Enforcement*: process and activities used to ensure compliance with laws, legislations, or regulatory instruments. An example is the “Compliance and Enforcement” activities for Drug and Health products [15].

III. REGULATORY ACTIVITIES

Oftentimes, government policies are elaborate and cut across more than one domain. For example, a policy on food safety with regulations can involve health, agriculture, and transportation. As such, it is common to see a regulator responsible for more than one regulatory instrument. Likewise, it is not uncommon to see more than one regulator responsible for one piece of legislation and hence, multiple regulators and regulatory instruments addressing one or more policy objectives at the same time.

Regulators administer regulatory instruments within the context of a lifecycle approach [16]. When observed from the viewpoint of what a regulator does daily, this lifecycle approach can be referred to as the *cycle of regulatory activities* [6]. The activities in the cycle consist of tasks that encompass the administration of regulatory instruments: their design, enforcement, and review. As illustrated in Fig. 1, the cycle comprises of three phases that can occur concurrently: *make*, *operate*, and *review*. In the *make* phase, activities include developing government policies into legislations and other regulatory instruments. This phase involves consultations with respective stakeholders at different stages of development, identifying the objectives of intervention and assessing the necessary case for action. Activities also include considering alternatives for meeting the identified objectives, evaluations of the effectiveness and efficiency of varying alternatives, as well as turning the chosen option or options into a legal instrument [6][17].

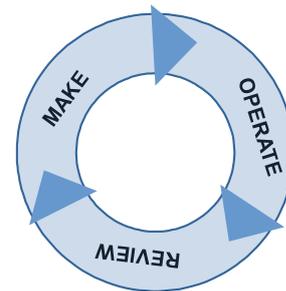


Fig. 1. Cycle of Regulatory Activities (adapted from [6])

In the *operate* phase, activities include applying the regulatory instrument daily to regulated entities in order to achieve the regulator’s public policy objectives. Activities in this phase include informing and educating regulated parties on the regulatory instruments, registering or licensing regulated parties, setting prices or terms and conditions, promoting and monitoring compliance, enforcing compliance, and handling complaints. In cases where there is an established public benefit, this phase also includes authorizing anti-competitive activities [6]. Finally, the *review* phase consists of activities involved in reviewing the regulatory instruments to ensure they continue to meet their specified objectives. Where the objectives of the regulatory instruments are not being met, changes to the legislation or alternate measures are considered. Reviewing regulatory instruments may also include performance assessments of the regulator’s processes, its regulatory objective, and considerations of improvement to the government policy [6].

The types of information systems currently used by regulators for the *cycle of regulatory activities* are often basic word processing systems. Most regulators, as part of their respective e-government strategies, would also have generic information systems. Such systems are generally used for reporting on the regulator’s activities, making announcements to the public, and obtaining feedback from the regulatory ecosystem. Examples of such systems include having an online presence (web sites, Twitter page, LinkedIn accounts, etc.). Information systems that can capture and link activities, data, or outputs in the *cycle of regulatory activities*, explore and accommodate different analysis and process efficiency activities are either rare or non-existent. Also, not much is available in the literature on the

regulatory ecosystem to show how currently existing information systems can be modified for the regulators [3]. As such, within the three phases of the *cycle of regulatory activities* opportunities exist for IS-based research to identify and address concerns and challenges regulators face in carrying out their mandates.

IV. RESEARCH METHOD

A. Source of Information

Our sample is composed of seven Canadian government agencies that have regulatory functions. We spoke with two senior executives of the Community of Federal Regulators (CFR) [18], a body that facilitates collaboration and the professional development of about 6000 employees involved in regulations across different agencies in the federal government of Canada. We used the CFR as a liaison to the agencies. The CFR identified suitable *Key Informants* [19], personnel considered having specialist knowledge on the respective regulatory functions of their agency. At least one of the Key Informants we talked with in each of the seven agencies was directly involved in administering regulations daily.

Also, given that most of the IS based research done on the regulatory ecosystem focuses on either the health domain or on addressing privacy concerns [3], we requested access where possible to agencies addressing other domains and concerns. In total, we gathered information from 25 Key Informants from the agencies (whose names as well as those of their employees are anonymized) as illustrated in TABLE I.

TABLE I. SOURCE OF DATA FOR THIS STUDY

S/N	Regulatory Domain	Agency	No. of Key Informant
1.	Health	Agency 1	6
2.	Health	Agency 2	3
3.	Health	Agency 3	1
4.	Public Safety	Agency 4	4
5.	Natural Resources	Agency 5	1
6.	Environment	Agency 6	9
7.	Fisheries and Ocean	Agency 7	1
TOTAL			25

In each case, we had one or more face-to-face interviews with each Key Informant.

B. Interview Questions

Our questions to the Key Informants were open-ended, as illustrated in TABLE II. We met in the Key Informants' offices and did not have a time limit for our discussions. This allowed the interviewees to discuss at length and address other topics relevant to the questions. We followed up on questions we perceived as promising based on the Key Informants' responses. In almost all cases, the Key Informants directed us to their agency web site for more information on their Acts, regulatory

instruments, annual reports, etc. This is because the Government of Canada, in practice, requires agencies to publish reports of their activities for online access by the public.

TABLE II. INTERVIEW QUESTIONS

S/N	Questions
1.	Tell us about your agency and your mandate.
2.	Who are the stakeholders involved in your regulatory ecosystem?
3.	What are the regulatory instruments you use to achieve your mandate? What are the processes or scenarios that guide or inform their choice?
4.	What are the challenges or concerns you have in carrying out your mandate?
5.	Can you tell us about the IS tools you currently use in administering regulations?

C. Analysis Procedure

Based on the nature of the data we collected, our analysis of is qualitative. We did not attempt to summarize our findings statistically. Instead, we applied thematic analysis [20][21] to understand significant themes in the responses provided by the Key Informants that spoke with us. We summarized these themes as follows:

- **Mission:** enables an understanding of why the agency exists, its objectives as well as its activities towards these objectives.
- **Regulatory Instruments:** enable an understanding of the regulatory instruments at the disposal of the agency, and the "how" and "when" they are used.
- **Specific Goals:** enable an understanding of the current or immediate mandate and focus of the agency as defined by the government of the day.
- **Measure:** enable an understanding of what is measured to show regulatory outcomes and how compliance with the regulation is assessed.
- **Information Management:** enable an understanding of the IS artifacts in use.
- **Challenges:** enable an understanding of issues the agency considers as challenges they encounter while trying to fulfil their mandate.
- **Opportunities:** enable identifying specific case scenarios where IS could be introduced to address concerns or challenges identified by the agency.

V. RESULTS

This section gives an overview of our findings for each of the seven anonymized agencies based on Key Informants' answers to our interview questions, complemented by public online information on the agencies' web sites. In order to respect the anonymity of the Key Informants and Agencies, we present the results of our analysis of the identified themes as follows:

Agency 1: This agency recently introduced a new regulation after an extensive and elaborate consultation process with stakeholders. The regulation was designed as outcome-based. The objectives of the regulation and supporting regulatory program are well defined. In addition, a systematic process is in place to inform and guide the selection of regulatory instruments to be used in meeting the regulation’s objectives. For further details on this agency, see TABLE III.

TABLE III. SUMMARY OF ANSWERS FROM AGENCY 1

Question Area	Response
Mission	Clearly indicates it is health related.
Regulatory Instruments	Acts Regulations
Specific Goals	The mandate addresses specific health related objectives
Measures	Licensing activities Risk assessments
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use. Legacy ISs are in place to facilitate administrative and compliance activities.
Challenges	Much data is collected from Canada-wide compliance activities. Questions arise on how data can be aggregated for comprehensive reporting on the compliance of regulated parties and the activities of the agency.
Opportunities	Case studies exist to determine what observed compliance levels mean relative to the regulation and its subsections, regions of the country or municipalities, and types of regulated parties. There are also opportunities to assess if the objectives of the regulations are being met and how (or what) regulatory programs contribute to meeting these objectives. Finally, there are opportunities to learn about the existing systematic process for selecting regulatory instruments toward formalization of this process for other agencies.

Agency 2: This agency’s activities are primarily operational. The emphasis is on enforcing compliance with regulations and other regulatory instruments. This agency collects a lot of data from its enforcement activities. With a strong and active online presence, feedback from the public is one of the information sources used to assess its transparency and accountability. For further details on this agency, see TABLE IV.

TABLE IV. SUMMARY OF ANSWERS FROM AGENCY 2

Question Area	Response
Mission	Clearly indicates it is health related.
Regulatory Instruments	Acts Regulations Regulations and Acts of other Agencies
Specific Goals	The mandate addresses health related objectives
Measures	Based on activities and targets needed to achieve the agency’s mandate

Question Area	Response
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use. The agency is actively involved on the web and has different supporting ISs.
Challenges	Different programs collect a lot of data on compliance activities. Data is also collected from the agency’s online activities. The agency has challenges combining data from these different sources to report on programs.
Opportunities	This regulator concentrates on evaluating the relevance and delivery of the programs that support regulatory instruments. There is, however, growing interest in evaluating how well the regulatory programs are performing, what has improved since the last evaluation activity, and if the regulatory instruments are meeting their intended objectives.

Agency 3: This agency’s activities are also primarily operational with many inspections targeted at establishing compliance with its different regulatory instruments. Although the inspections process has some automation, data collected do not show much on compliance or the regulatory instruments. Regulations are often changed with sections repealed to accommodate the dynamic landscape of the domains this agency manages. This agency also has a strong and active online presence. Further details are available in TABLE V.

TABLE V. SUMMARY OF ANSWERS FROM AGENCY 3

Question Area	Response
Mission	Health related with overlaps in other domains.
Regulatory Instruments	Acts Regulations Orders Regulations and Acts of other Agencies
Specific Goals	The mandate addresses health-related objectives in all domains the agency is involved.
Measures	Compliance of end users Sample data from select population Public opinion research Recalls
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use. ISs to handle online activities and a Records Documents and Information Management System.
Challenges	Programs are built around and used to deliver on the objectives of regulatory instruments. Data is collected and shared to show that programs have been delivered rather than to show the societal impacts they achieved.
Opportunities	There are interests in improving the overall efficiency of inspections activities, targeted use of data and continuous improvement of other regulatory functions. Opportunities exist for better monitoring of compliance with regulatory instruments through linking inspection activities directly to the parts of the regulatory instrument they address.

Agency 4: Although this agency has its own regulatory instruments, it also serves as a delivery arm for other agencies. Efforts have been made to define core functions and capabilities and their existing links to each other, and corresponding regulatory instruments. A systematic approach to creating indicators for measurement is in place, leading to the collection of a large amount of valuable data thus creating a need for useful analysis. For further details on this agency, see TABLE VI.

TABLE VI. SUMMARY OF ANSWERS FROM AGENCY 4

Question Area	Response
Mission	Address public safety overlaps in other domains.
Regulatory Instruments	Acts Regulations Tariffs Regulations and Acts of other Agencies
Specific Goals	Centered on ensuring safety
Measures	Compliance of end users
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use. Efforts in place on improving data governance and analytics.
Challenges	Although this agency collaborates substantially with other agencies, work with its collaborators is currently done in silos, with each agency doing their own thing. This has led to repetition of roles and activities. The key performance indicators (KPIs) in use only show traceability between the agency's capabilities, its activities, and its regulatory instruments, and are not for analyzing outcomes.
Opportunities	There is increasing interest by this agency to improve information sharing aspects with its collaborators. They are also interested in exploring the impact of their activities on the economy and society as well as what they contribute to the regulatory instruments under their purview.

Agency 5: This agency uses a regulatory framework comprising of laws, regulations, licenses, and documents that specifies how the domain under its purview should be regulated. Standards produced by the CSA Group [22] are used to clarify its regulations, and these standards are some of the tools this agency uses to evaluate licensees. More information on this agency is available in TABLE VII.

TABLE VII. SUMMARY OF ANSWERS FROM AGENCY 5

Question Area	Response
Mission	Address issues around natural resources and public safety.
Regulatory Instruments	Acts Regulations Codes Standards
Specific Goals	Centered on managing natural resources properly

Question Area	Response
Measures	Compliance Licensing
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use. Efforts in place on improving data governance and analytics.
Challenges	Although indicators are available for various forms of oversight, their use is limited to communication and monitoring, and to some extent to informing the focus of regulatory activities. Also, there is currently little reuse of the data obtained during regulatory activities to improve the agency's functions.
Opportunities	This agency would like to improve the use of data for regulatory activities and to improve on its overall efficiency and effectiveness. Also, there is interest in properly structuring and reducing the number of indicators to target measures appropriately.

Agency 6: This agency puts much emphasis on research to guide evidence-based decision making. An instrument choice framework provides knowledge and proven practices on determining the most appropriate instrument to use to manage risk. This agency currently describes the performance of regulatory instruments as what has been done or will be done rather than as observed or obtained impacts. For further details on this agency, see TABLE VIII.

TABLE VIII. SUMMARY OF ANSWERS FROM AGENCY 6

Question Area	Response
Mission	Address environmental issues
Regulatory Instruments	Acts Regulations Conventions Standards Agreements Permits Registries
Specific Goals	Centered on managing the environment
Measures	Compliance Outcome of programs
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use. Certain programs have some legacy software to support their work.
Challenges	Regulatory activities depend much on time, making attributions difficult. Also, there are limited resources (human and capital).
Opportunities	There is interest in identifying more systematic ways of showing how regulatory instruments and programs are performing, especially over time. In addition to determining performance of regulatory instruments, this agency is currently exploring how to capture the entire development process of regulatory instruments to enable assessments of what resources (human, capital, data, technology, etc.) are required at each phase.

Agency 7: This agency has many supervisory roles. In addition to licensing and enforcement activities, much collaborative work is done with agencies of the provinces (of Canada). The provincial agencies have different regulatory instruments they have individually created and use. For further details on this agency, see TABLE IX.

TABLE IX. SUMMARY OF ANSWERS FROM AGENCY 7

Question Area	Response
Mission	Address marine issues
Regulatory Instruments	Acts Regulations
Specific Goals	Centered on managing aquatic life and environment
Measures	Compliance Licenses
Information Management Tools	Basic information management (IM) tools; mainly Microsoft Office-related products are in use.
Challenges	Each province in this domain has created and uses its own regulatory instruments. This gives rise to duplication of roles and activities requiring continuous alignment of both types of regulatory instruments to ensure reduction of administrative burden on regulated parties.
Opportunities	This agency is currently reviewing some of its regulatory instruments. As such, there is interest in identifying relationships between its regulatory instruments and those of other provincial agencies to determine their individual contributions. Also, there is interest in exploring what contributions the programs of the agency and its provincial counterparts make to the overall mission of the agency.

VI. INTERPRETATION OF RESULTS

In interpreting the results obtained after our thematic analysis of the information provided by the Key Informants, we compared the descriptions of the agency's activities with the *cycle of regulatory activities*, in order to check whether they are aligned. In certain cases, where we were uncertain, we sought clarification by reviewing the information available on the agency's web site as well as by sending follow-up emails to the Key Informants. Based on our contact with the seven agencies and on our exploration of how they individually function within the *cycle of regulatory activities* [6], we identified seven key IS-related issues faced today by Canadian agencies while carrying out their respective mandates.

These issues are described according to the make, operate, and review phases of the *cycle of regulatory activities*:

A. The Make Phase

1) The Nature of Regulatory Activities

There is often overlap and redundancy in governments today. Different agencies have oversight over the same issues and units/sections of a given agency could also oversee identical things. In some cases, different agencies will individually contribute to different parts of a government's policy objective or regulatory instrument. Similarly, in relation to regulators and

their functions, similar overlap and duplication exist. In some cases, a regulator might not own the regulatory instrument, or it might be responsible for the enforcement and not be involved in the development or review of the corresponding regulatory instrument. This creates scenarios whereby regulators who might have the knowledge of how a policy objective could be achieved are not part of the development or review of regulatory instruments. Also, in carrying out their respective functions, regulators often select regulatory instruments based on their respective mandates and directly related to the parts of the legislations under their purview.

This limits information sharing as the regulators end up working in silos. The application of business process alignment techniques and traceability links could prove useful in addressing these challenges. This is because determining if and how regulators or regulatory instruments meet their intended objectives would benefit greatly from aggregating individual contributions involved in administering the legislation.

2) Choosing Regulatory Instruments

In the *make* phase of the *cycle of regulatory activities*, government policies are developed into legislations and other regulatory instruments that the regulator can administer. Currently, regulators can show some success in this regard, specifically with the use of regulatory impact assessments (RIAs). A RIA is a systemic approach to critically assess the positive and negative effects of proposed and existing regulations and non-regulatory alternatives [23]. Regulators in different domains currently apply RIAs differently, making it difficult to identify what works and what should be improved. Despite individual successes in the use of RIAs, such assessments often do not meet their intended expectations. RIAs offer opportunities for considering alternatives in relation to an individual legislation in its entirety. There are limited options to choose from based on the estimated impact of sections or subsections of the legislation. RIAs offer a limited view of the impact of a specific proposed measure or group of measures. Also, classical RIA techniques cannot be used for assessing the impact of all legal norms in a legislation due to their volume [24].

None of the agencies we spoke with evaluates its RIAs to see how they are performing, even if the RIA process is mentioned in the respective regulatory process. Existing knowledge within IS research could be applied to the process of choosing regulatory instruments. This would offer opportunities to innovate in exploring the best alternatives to use to meet the objectives of government policies and legislations.

B. The Operate Phase

1) Big Data and Data Analysis

Nowadays, organizations such as regulators collect enormous amounts of data from their daily activities. Challenges continue to exist concerning how to exploit these data due to poor data quality, increasing security and privacy concerns, and the costs of data management. Deriving insights from the data regulators collect is further challenged because of the unique nature of regulatory activities. An agency that is responsible for more than one regulatory instrument would also be faced with different data concerns for each regulatory instrument involved. Also, an agency that contributes to only a subset of a

given regulatory instrument might need the data obtained by other regulators from other subsets of the regulatory instrument. These scenarios could cause serious data management problems for regulators, where each regulator uses a different ISs to collect and manage data. In addition, most ISs in use by regulators are specialized legacy systems and are not designed to communicate easily with other ISs. Research on Big Data and data analytics could consider the unique regulatory environment and offer tools and technique regulators can use to address their problems with the collection, storage, and retrieval of data.

2) *Dynamic Nature of Domains*

The internet is changing the way regulated parties operate today through ease of electronic communication, increasing growth in ecommerce activities, and the introduction of disruptive technologies such as the internet of things. Equally, the internet is creating new challenges and concerns to the regulatory ecosystem especially in terms of security and privacy. Regulators are now faced with new threats and challenges that existing regulatory instruments were not designed to address. There is an increasing need for regulators to adapt their activities and regulatory instruments to accommodate such dynamism in the respective domains under their purview. One such adaptation is the introduction of the National Institute of Standards and Technology Cybersecurity Framework (NIST CSF) [25] to augment cybersecurity regulations. In this respect, regulators would benefit from elaborate IS-based research targeted at addressing adaptation in sociotechnical systems.

C. *The Review Phase*

1) *Performance of Regulatory Instruments*

How do we ascertain whether the legislations enacted by governments and administered by regulators are performing? In the *review* phase of the *cycle of regulatory activities*, regulators' activities involve reviewing whether policy objectives have been met through reviewing a) the instruments the regulator uses to meet these objectives, and b) the regulator's associated processes and capabilities. The current emphasis of regulators, however, is on determining how well programs that support regulatory instruments were delivered and not how they performed or if the regulatory instruments they support delivered on their objectives. Reasons for this include regulators focusing too much on the cost of administering regulations and their relevance, and regulators being unsure of what to measure to show performance and societal impact. Also, not much is understood of data requirements coupled with disparate information systems in use by regulators involved in administering regulations [26]. This often leads to an emphasis by regulators on counting outcomes met instead of analyzing impacts achieved. As such, the *review* phase of the *cycle of regulatory activities* happens to be the phase described as the most challenging for the regulators with whom we spoke. This concern of the *review* phase is further validated in recent reviews [1][2][3]. Regulators are beginning to explore how to identify the relationships between elements of programs, the regulations they support, and the target societal objectives. Knowledge within IS research on traceability and performance measurement and analysis could prove useful in enabling regu-

lators to show the performance and effectiveness of regulations and regulatory instruments and programs.

2) *Regulatory Maturity*

Most regulators have similar activities, regardless of the domain of oversight. In this context, collaboration and sharing of knowledge amongst regulators, which is the mandate of bodies such as the Community of Federal Regulators [18], become necessary. In addition, arriving at a benchmark for comparison and reference based on proven practices amongst regulators would prove useful. In most domains, maturity models are used to achieve such benchmarks. Maturity models postulate a series of maturity levels for a class of objects or activities. They represent an anticipated desired or typical evolution path of these objects (organizations, processes, etc.) shaped as discrete stages [27][28]. A maturity model can describe patterns in the development of organizational capabilities, either for individual entities or a complete set of organizational capabilities. What are the capabilities required for regulators in line with proven practices? How do regulators measure against such capabilities? How can a regulator identify, diagnose, and eliminate deficient capabilities based on the knowledge of current and desirable maturity levels? IS research on maturity models would prove useful in enabling regulators to address such questions and offer opportunities to improve regulatory practice.

3) *Accountability and Transparency*

Because of recent global crises (financial crisis of 2008, British Petroleum oil spill in 2010, change in political leadership in many countries, etc.), there is growing interest about regulators and how they carry out their mandates. How a regulator relates and co-ordinate with all parties in the regulatory ecosystem, what powers it has, and how it is held accountable for exercising these powers are now common questions. A regulator is supposed to be accountable to governments as provided in the enabling legislations and is legally bound to adhere to proper standards of accounting and compliance with independent auditing [29]. Guidelines and principles such as the *OECD's Best Practice Principles for Regulatory Policy: The Governance of Regulators* [6] describe that there should be clarity on what is expected from a regulator and what they can do to meet these expectations. Furthermore, decisions on policy priorities and objectives, for which elected governments are responsible, should be clear from regulatory decisions that contribute to achieving these objectives, for which regulator are responsible. Such guidelines and principles are internationally recognized and can be used by regulators to show that they are accountable and transparent. However, it is unclear how these guidelines and principles can be assessed or evaluated to determine how accountable or transparent a regulator is. Another question is what levels of accountability or transparency are considered appropriate or can be attributed to a regulator if only certain aspects of the guidelines and principles are met. Regulators can take advantage of modelling methods such as goal modelling to analyze and show their accountability or transparency.

VII. THREATS TO VALIDITY

1) *Internal Validity*: This refers to how well we carried out this research. To identify suitable Key Informants from many

domains, the CFR [18] served as our liaison. As such, agencies we were in contact with were identified by the CFR, resulting in suitable Key Informants for this research. This also helped mitigate some bias we might have had in the selection of informants. However, the collection of data was mainly done through informal meetings and additional emails, so it is still possible we may have misunderstood or misrepresented the information shared by the Key Informants.

2) *External Validity*: This refers to the generalization of the results of this research. We spoke to 25 Key Informant Key Informants amongst regulators, who are subject matter experts in their respective domains, to have an understanding of the state-of-practice of regulators. Although we attempted to cover many organizations (seven) and regulatory domains (five) in Canada, this still only represents a small fraction of the stakeholders in that space (e.g., CFR has thousands of members from 27 Canadian departments and agencies). Hence, our conclusions may reflect only a fraction of the real challenges regulators are facing, especially as the organizations that were contacted are all Ottawa-based federal regulators. However, to further mitigate this threat, the seven sets of challenges we reported here were classified according to the phases and activities identified in the *cycle of regulatory activities* [6], which are country and domain independent.

VIII. CONCLUSION

We have highlighted key issues that concern the regulatory process and their implications for the IS research agenda. We looked at the activities regulators perform daily in administering regulations and other regulatory instruments to understand regulator practice. This enabled us to characterize a partial view of the state-of-practice in Canada and identify key challenges and concerns that the application of ISs can address to improve the practice of regulatory management. This application of ISs and improvement of the practice of regulatory management will create opportunities to better understand and theorize how IS and regulatory instruments or proven regulatory practices relate. In addition, IS researchers will be able to understand and theorize on the impacts of ISs and related requirement practices on regulatory process implementations and their outcomes. We are not oblivious to the risk that we have missed some important problems in the regulatory process. A focus on the issues regulators encounter is a needed step towards better governance in the face of an influx of disruptive transformations. In this context, an improved, IS-supported regulatory process could eventually prove useful in making regulators better equipped to administer regulatory instruments to achieve societal benefits and manage the expectations of the different stakeholders in the regulatory ecosystem.

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