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RESEARCH ARTICLE

REGULATING EMERGING TECHNOLOGIES: PROSPECTIVE SENSEMAKING THROUGH ABSTRACTION AND ELABORATION[1]

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Emerging digital technologies require regulation that will avoid harmful effects but that also, ideally, fosters innovation. We report on a case study of how actors, representing a variety of perspectives (legal, regulatory authority, government, industry, and technology), interacted to construct a law on trustworthy technology in the European state of Liechtenstein. This regulatory construction was enabled by collective prospective sensemaking relying on the interrelated processes of abstraction and elaboration, through which actors collectively reconceptualized the regulatory target in terms of the technology (from blockchain to trustworthy technology), its uses (from cryptocurrency to token economy), and required roles (from financial service provider roles to trustworthy technology systems roles). Abstraction allowed the group of actors to extract and generalize essential properties to support the regulatory goals of technology neutrality and innovation-friendliness. Elaboration allowed the group to identify and specify details and requirements to support the regulatory goals of creating legal certainty and protecting users. Through these processes, actors could construct a shared, collective understanding that accommodated various viewpoints and paved the way for writing a law. From this case study, we develop a theory of collective prospective sensemaking in regulating emerging technologies.

Keywords: Technology regulation, prospective sensemaking, sensemaking, institutional construction, emerging technology, blockchain, token economy

Introduction

Emerging technologies like artificial intelligence (AI), blockchain, and the Internet of Things (IoT) can create regulatory gaps, such as when they allow new practices or present the possibility of new consequences (Mandel, 2009). This issue can require constructing new regulatory institutions or adjusting those that already exist (Beaumier et al., 2020; Scherer, 2015; Székely et al., 2011). A key challenge in regulating emerging technologies lies in avoiding harmful effects and ensuring the technology is deployed in a socially desirable way (Braun & Wield, 1994) while also being innovation friendly (Butenko & Larouche, 2015; Butler et al., 2023; Finck, 2018; Henningsson & Eaton, 2023; Mandel, 2009). Accomplishing this dual goal is particularly difficult when the technology's prospects and potential uses are unclear at the time of regulation (Bennett Moses, 2013; Collingridge, 1980; Finck, 2018). The fast pace and unbounded nature of technological development (Grover & Lyytinen, 2023) challenge established regulatory processes (Brownsword, 2020;

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Brownsword et al., 2017), which are typically slow-paced and territorially bounded (Beaumier et al., 2020). Governments are typically "behind the curve of technology (compared to industry)" (Wiener, 2004, p. 489). The time lag that may result provides a "gray" space for experimenting with new business models (Hinings et al., 2018).

Therefore, a central question concerns how lawmakers can create regulations that are specific enough to support appropriate control but also flexible and general enough to allow for a technology's future development and to cope with technological change and innovation. In regulation's broadest sense, it seeks to maintain a system's desired state (Braun & Wield, 1994); it is a core means of controlling technology and behavior associated with that technology to avoid risk and societal as well as environmental damage (Braun & Wield, 1994) through rules or restrictions (Koops, 2006). Regulation can take different forms, including government regulation, self-regulation, and market regulation (Koops, 2006). Different regulatory designs can shape technological development in ways that impede or stimulate change, such as when specific command-and-control technological requirements may lead to the diffusion of existing technology but prevent innovation, or when setting performance standards while allowing for flexibility as to "how" these standards are met can foster innovation (Wiener, 2004). Key elements of regulations are the laws and bylaws that legislatures pass, the orders issued by ministers or local authorities that specify details, and the assignment of agencies that are responsible for day-to-day enforcement (Braun & Wield, 1994).

Two broad options that have been suggested in this context are *technology neutrality* and *technology specificity* (Greenberg, 2015; Reed, 2007). Technology neutrality refers to regulating technology in such way that is does not discriminate against any specific technology and can apply to both offline and online technologies (Koops, 2006). It is widely adopted in law-making, including in the European Union (EU) and the United States (US), and is intended to make room for technological development and innovation (Reed, 2007; Székely et al., 2011). The US Government's Framework for Global Electronic Commerce states that "rules should be technology-neutral (i.e., the rules should neither require nor assume a particular technology) and forward looking (i.e., the rules should not hinder the use or development of technologies in the future)" (The White House, 1997). The EU has described the goals of the AI Act similarly: "Parliament … wants to establish a technology-neutral, uniform definition for AI that could be applied to future AI systems" (European Parliament, 2023a). Technology specificity, which argues for regulating specific technologies individually, highlights that technology neutrality may not be desirable because, for example, it cannot be specific about what it regulates, which may lead to unintended consequences. Technology neutrality also may not be feasible because, for example, regulators do not fully understand the technology and judges will eventually have to conceptualize the technology in court (Greenberg, 2015; Koops, 2006; Reed, 2007).

Constructing an agreement on how an emerging technology should be regulated, including the degree to which it should be technology-neutral or technology-specific, is not an easy task. Regulating emerging technologies is an act of institutional construction (Scott, 2014) that involves multiple actors or agents (Colomy, 1998; Fligstein, 1997; Kokshagina et al., 2023) whose perspectives can differ (Chan & Bennett Moses, 2017). The state plays a dominant role in technology regulation, but other actors can also be involved (Gornitzka & Sverdrup, 2008; Rasmussen & Toshkov, 2013). This can be expert groups that represent stakeholder groups and associated perspectives, such as regulatory agencies, industry representatives, scientists, environmental organizations, and public interest groups (Mandel, 2009). These actors must collectively make sense (Stigliani & Ravasi, 2012; Weick et al., 2005) to move from multiple and sometimes conflicting points of view to some shared understanding of the regulatory target. A key challenge is that emerging technologies are equivocal because they evoke or are associated with multiple, conflicting interpretations (Berente et al., 2011; Weick, 1990). Therefore, we ask: *How do actors who are involved in developing regulatory frameworks make sense of emerging and equivocal technologies so as to regulate them?*[2]

In seeking answers to this question, we conducted an in-depth exploratory case study of the process of making a law on trustworthy technology in the European nation-state of Liechtenstein. The process started with the intention to regulate blockchain technology but eventually led to making a law on tokens and trustworthy technology service providers. Our focus was on the country's process of developing the regulatory framework to the point at which it was discussed in Parliament and passed as a law. We conducted interviews with the key individuals involved in the process's various stages, from forming a working group of experts in response to regulatory pressure and stakeholder interests to iteratively developing a new regulatory framework to writing the law. Respondents represented a variety of perspectives, including those of the prime minister, lawyers, technical experts, and industry professionals. We also referred to key government and public documents, including concepts, strategy papers, working group documents, political reports, and the

[2] The research question was adjusted during the course of the qualitative, exploratory study, but it remains aligned with the overall goal of understanding the regulatory process.

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evolving text of the law itself, including annotations and comments, all of which provided insight into the law-making process throughout its stages over time.

Our theoretical contribution involves highlighting how collective prospective sensemaking around emerging technologies relies on the interrelated processes of abstraction and elaboration, with which actors collectively and discursively extract and generalize essential properties (abstraction) and specify details and requirements (elaboration). If applied in the context of technology regulation, abstraction and elaboration move the regulatory process from one conceptualization to another and allow actors to construct shared meaning, so they are critical elements in institutionalizing regulations for equivocal and emerging technologies.

This article proceeds as follows. First, we elaborate on our theoretical lens of collective prospective sensemaking. Then we describe our research method. Next, we discuss our case analysis in two steps: the description of the context and the overall temporal development, followed by our analysis of how actors constructed meaning through prospective collective sensemaking and how they encoded this meaning in a regulatory framework. Our penultimate discussion section develops a process model of regulating emerging technologies. Finally, we highlight the study's implications for research and practice and conclude by pointing out the study's limitations and making some final remarks.

Collective Prospective Sensemaking About Emerging Technologies

Understanding emerging and equivocal technologies requires sensemaking (Berente et al., 2011; Mesgari & Okoli, 2019)—the process through which individuals and groups interpret novel and ambiguous situations by identifying and bracketing cues, creating intersubjective meaning, and enacting this meaning (Maitlis & Christianson, 2014; Weick, 1995; Weick et al., 2005). Three aspects of sensemaking are of particular importance when actors seek to understand emerging and equivocal technologies so as to regulate them: Regulatory sensemaking involves both individual actors and collectives, sensemaking about emerging technologies is discursive, and sensemaking about emerging technologies is both retrospective and prospective.

First, since regulatory sensemaking involves both individual actors and collectives, it can be viewed as both a cognitive process, emphasizing the role of the individual actor (Dervin, 1999; Klein et al., 2006; Louis, 1980), and a social process that puts the collective in the foreground (Maitlis et al., 2013; Weick, 1995; Weick et al., 2005). We study sensemaking as a social process in which individual actors, each with their own perspectives and goals, collectively create meaning around an emerging technology (Gattringer et al., 2021) to construct a regulatory framework. While we consider the unique viewpoints of individual actors, making a law is a consensus-seeking process that can succeed only if shared, collective meaning is created.

Second, discourse is central for sensemaking to create intersubjective meaning (Berente et al., 2011; Gephart et al., 2012; Weick et al., 2005). Weick (1995, p. 18) aptly highlighted the role of language in sensemaking: "How can I know what I think until I see what I say?"—a slight adaptation of the phrase he attributes to Graham Wallas. Next to conversational practices, collective sensemaking involves the use of artifacts, including a variety of visual and textual forms that allow actors to articulate their assumptions and beliefs, represent aspects of their thinking that they deem to be relevant, elaborate on their understanding, and construct shared meaning (Stigliani & Ravasi, 2012). This is of particular importance when constructing a law, because the outcome of this process is an artifact (the law text), that represents the shared meaning that the legislature eventually passes (Kosti et al., 2019).

Third, despite the early tendency of the sensemaking literature to focus on retrospection (Weick, 1995; Weick & Meader, 1993), sensemaking is also prospective (Bolander & Sandberg, 2013; Corley & Gioia, 2011; Gioia, 2006; Gioia & Chittipeddi, 1991; Gioia et al., 2002; Thomas et al., 1993; Weick et al., 2005) or future-oriented (Gephart et al., 2012; Stigliani & Ravasi, 2012). On the one hand, when making sense of a situation, actors build on previous experiences (Weick, 1979), including their experiences with the emerging technology as well as other technologies. On the other hand, sensemaking allows actors to engage in forward-looking thinking (Friesl et al., 2019; Gattringer et al., 2021; Stigliani & Ravasi, 2012), which is key to a regulatory effort that seeks not only to regulate the status quo but also to regulate future developments of an emergent and equivocal technology like blockchain (Finck, 2018; Greenberg, 2015).

Research Method

We conducted a single in-depth case study, drawing on techniques from the grounded theory method (Strauss & Corbin, 1998) to build theory, particularly process theory (Langley, 1999). Single case studies allow researchers to develop a deep understanding of a phenomenon in its socially embedded context and to study novel and emergent phenomena (e.g., Davidson & Chismar, 2007). We had access to a unique site and data that allowed us to study regulatory sensemaking around emerging technologies in depth and give consideration

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to multiple viewpoints (e.g., Cross et al., 1997; Silva & Hirschheim, 2007). Our main data sources were government documents and interviews with key actors involved in the regulatory effort. The interviews allowed us to understand the law-making process from the perspectives of those involved (Rubin & Rubin, 2012), including what they deemed to be important about the technology and how they saw the understanding of the regulatory target evolving over time. Time-stamped documents were especially helpful in constructing a time-ordered account of events (Langley, 1999). They also provided insights into how collective meaning was constructed over time, as these documents reflected the conceptualizations of the technology at various points in time. To ensure transparency, we provide additional information about our data collection and analysis on an open science server at https://osf.io/y698b/.

Case Setting and Technology

The nature of blockchain as an emerging technology and the opportunity to observe multiple actors involved in constructing a regulatory framework for it in Liechtenstein made the case well suited to a study of regulatory sensemaking around emerging and equivocal technologies.

Located in central Europe, Liechtenstein offers a high standard of living, a strong overall economy, and a particularly strong financial sector. The country's strong financial sector and its government's awareness of the need to strengthen the country's ability to innovate in light of emerging financial technologies (fintech) in the context of the highly regulated nature of financial markets made blockchain a focus. However, Liechtenstein had no formal regulatory framework for blockchain technology, as was also the case in most other countries, so we were in a position to observe the construction process of a novel regulatory framework. Actors at the government level and innovators, including technology enthusiasts who were interested in the new technology, both identified a regulatory gap when they discovered blockchain's innovation potential and that the existing regulations were not sufficient. Multiple actors whose perspectives and goals differed participated in the process.

Blockchain is an emerging technology that has the potential to change business transactions (Finck, 2018; Herian, 2018; Kiviat, 2015), including monetary processes (Tsukerman, 2015), in general, along with other uses (Beck et al., 2018; Mendling et al., 2018). Blockchain can be considered a "tamper-resistant database of transactions consistent across a large number of nodes" that increases trust, as it is cryptographically secured against manipulation (Beck, 2018, p. 55). However, blockchain's potential cannot be fully anticipated (Beck et al., 2018): While the technology has its roots in its use for cryptocurrencies, notably Bitcoin (Nofer et al., 2017), it has broad applicability in representing all sorts of assets through tokens. Such is the foundation of the token economy, where a token—a piece of information—can represent a variety of assets (Chen, 2018). Therefore, what products, services, processes, and business models blockchain technology will eventually enable is not predictable (Finck, 2018). As a result, regulatory bodies like governments must anticipate the actionable spaces that this technology may provide, as well as the consequences of such provision (Finck, 2018; Herian, 2018; Kiviat, 2015). At the same time, business organizations require regulatory frames if they are to make decisions about investments and change their work practices and business models. In short, they need legal certainty (Finck, 2018).

Data Collection

We collected data between April 2019 and December 2022. The main phase of our data collection took place between April 2019 and July 2019, but in the spirit of theoretical sampling (Strauss & Corbin, 1998) inquiries continued as we analyzed our data, sampled documents from available data sources, and conducted confirmatory interviews in 2021 and 2022. Our primary data source in the first phase was the semi-structured, open-ended, retrospective interviews with those individuals who were directly involved in the process of creating the law. We conducted 20 interviews with 20 unique respondents (Table 1) and three follow-up confirmatory interviews with three key respondents. The length of the interviews averaged 50 min 18 s and ranged from 25 min 14 s to 92 min 2 s. The interviews involved participants who represented key perspectives: technology experts from the emerging crypto ecosystem and legal, financial market supervision, government, and industry professionals. Key questions addressed the goals, process, and results of the regulatory process from the respondents' points of view. As Table 1 shows, these actors were part of a core working group or an extended working group or participated in the process in various other capacities. We explain the role of each of these groups later in our analysis section. The sample represented the key actors involved in the process, including all members of the core working group and the extended working group, as well as other key individuals. Among the interviewees were the prime minister, an employee of a ministerial unit, a member of the executive board of the financial market authority, key legal advisors, and technical experts. When conducting the interviews, we used an interview protocol as a guide but made adjustments to consider and understand each actor's idiosyncratic role and perspective in the process. We provide additional information about how we gained access to the case site and identified key informants as well as about the interviews and interview settings and how interviews were adjusted at https://osf.io/y698b/.

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Table 1. Respondents

Respondent				Group membership			No. of interviews
ID	Organization	Role	Perspective	Core working group	Extended working group	Other	
1	Financial market authority	Executive	Regulatory authority	x	x		2
2	Law firm	Founder, executive, lawyer	Legal, technology expert	x	x		2
3	Trust company	Owner, lawyer	Industry, legal	x	x		1
4	Crypto association	Board member	Industry, professional association			x	1
5	University	Professor	Academic (law)		x		1
6	Bank	Financial markets executive	Industry			x	1
7	Law firm	Founder, executive, lawyer	Legal			x	1
8	Crypto company	Executive	Industry			x	1
9	University	Professor	Academic (law)		x		1
10	Tax consultancy company	Founder, executive	Industry			x	1
11	Crypto company	Founder, executive	Industry, technology expert	x	x		1
12	Law firm	Executive, lawyer	Legal		x		1
13	Law firm	Founder, executive, lawyer	Legal		x		1
14	Crypto company	Founder, executive	Industry, legal			x	1
15	Ministerial unit	Employee	Government	x	x		2
16	Crypto company	Executive	Industry			x	1
17	Crypto company	Founder, executive	Industry, technology expert	x	x		1
18	Crypto association, crypto company	Board member, executive	Industry, professional association			x	1
19	Crypto association, crypto company	Board member, executive	Industry, professional association			x	1
20	Government	Prime minister	Government			x	1
Totals				**6**	**10**	**10**	**23**

Official government papers—concept and strategy papers and other documents related to the project—helped us get a comprehensive picture of how the process unfolded. We sampled from nearly 1,000 documents for those that we expected would help us develop our emergent concepts and move toward theory. Our complete sample consisted of 19 hr 17 min of interview data, 1,688 A4 pages of documents, and 286 PowerPoint slides (i.e., a total number of 1,974 document pages). Table 2 provides an overview of the documents we analyzed.

Data Analysis

We conducted four rounds of coding with the first two authors[3] performing the coding process and one or the other taking the lead in each of the four key coding stages. The two authors held regular meetings to review the coding, discuss emergent codes, and resolve any disagreements to reach a consensus. By comparing and contrasting codes with empirical data (Strauss & Corbin, 1998), they reached consensus in all instances. In this process, they created, densified, and reordered more than 200 codes. We used the ATLAS.ti software (first in Version 8 and later in Version 9) to facilitate the coding process, Excel to create tabular displays of data and analyses, PowerPoint to visualize data and findings and develop conceptual ideas, Word to record and develop ideas, and Python scripts to query documents. We provide additional information about the coding process at https://osf.io/y698b/.

[3] The second author's position as a government official (advisor to the prime minister) enabled access to respondents and data, as well as the acquisition of the required permissions for its use, but did not involve active participation in constructing the law; he thus took an observational role for the purpose of our study. However, he was continuously informed about the process and coordinated related government communication with political parties and the public, enabling the research team to make informed sampling decisions. The involvement of the two analysts (the first and second authors) helped mitigate potential researcher bias. Additional details about the second author's position and role are available at https://osf.io/y698b/.

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Table 2. Documents Analyzed (sampled from approx. 1000 documents)

Document type	Description	Sampled documents
Concepts	Documents that highlight and discuss elements of the regulatory effort	7
Strategy documents	Documents that highlight strategic decisions, such as alternative options throughout the process	5
Working group documents	Documents used in the core working group and extended working group to facilitate the process	6
Report and proposal / emerging law text	Evolving versions of the law text, sometimes including an explanatory part preceding the law and including feedback and opinion provided by stakeholders throughout the law-making process; the law text was the central evolving artifact	14
Overview of feedback received	A list that summarized the feedback received on the proposed law	1
Government programs and reports	Overall program published by the government, providing a sense of the external perception of the process	7
Communications and media	Communication about the law-making process, for instance, through speeches, interviews, and press releases	12
Parliamentary protocol	Decision protocol of the parliamentary process	2

First Round of Coding: Identifying the Overall Process

Open coding (Strauss & Corbin, 1998) soon produced more than 100 codes. The first two authors' review of these codes pointed to several emergent themes, particularly the temporal development from a more specific (albeit still vague) understanding of "regulating cryptocurrencies" to the more abstract and general understanding of "making a law for the token economy." We noticed that this shift resulted from the working group members' interactions with each other, their interactions with other actors, and a process that could be best described in terms of sensemaking and the formation of shared collective meaning. The open coding soon overlapped with axial coding (Strauss & Corbin, 1998), where we began to identify major categories and to code around the "axes" of these categories; that is, we started to identify relationships. While we were sensitized by the coding paradigm suggested by Strauss and Corbin (1998), which suggests using the categories of phenomenon, causal conditions, intervening conditions, contextual conditions, action/interaction strategies, and consequences to identify relationships, we only used these ideas as a jumping-off point to avoid force-fitting data (Seidel & Urquhart, 2013). In particular, our coding revolved around the idea of "prospective sensemaking" as the process by which actors sought to understand and anticipate the materiality (in terms of features) and potential uses of blockchain technology. Therefore, we decided on our theoretical lens of sensemaking to analyze how actors tried to comprehend, explain, and predict the role and implications of blockchain technology and to construct shared meaning (Stigliani & Ravasi, 2012; Thomas et al., 1993; Weick et al., 2005). In the grounded and exploratory spirit of this study, we used sensemaking as a "sensitizing device" (Klein & Myers, 1999). That is, to allow for codes to emerge, we allowed ourselves to be sensitized by ideas from sensemaking theory (such as triggered by ambiguity, involving labeling) rather than applying preconceived concepts to our data (Strauss & Corbin, 1998). The key elements that informed our analyses were our conception of prospective sensemaking as an individual and collective, discursive, and prospective process by which actors create meaning around emerging technologies to regulate them. Throughout the process of analyzing our data, we considered other lenses, like institutional entrepreneurship theory and stakeholder theory, but we settled on sensemaking because it allowed us to attend to how actors who represented various perspectives were involved in assigning meaning to the emergent technology. We considered this lens to be suitable because, more than other lenses we considered, it highlighted how actors collectively moved through a discursive process from an ambiguous understanding related to "regulating blockchain" to a conceptual understanding of making a law on tokens and trustworthy technology service providers, thereby considering the prospective nature of the regulatory effort.

Second Round of Coding: Focus on Prospective Sensemaking

We recoded our data set with a focus on sensemaking and noticed that the sensemaking-related codes fit into three categories: *making sense of materiality*, *making sense of*

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use/potentials, and *making sense of required regulation*.[4] These categories helped us to conceptually describe the sensemaking process that we saw as revolving around key elements of the regulatory target in terms of the technology itself (asking and answering questions about *what is* the technology of interest), the technology's uses (asking what *can be done* with the technology, that is, its outcomes), and the required roles (*who* should be regulated and *in what capacity*, that is, behaviors and related responsibilities and obligations). As in the first round of coding, we remained open to discovering something new in the data while we focused on axial coding around the three emergent categories. Table 3 provides examples from this stage of coding. The table also illustrates the general logic of our concept formation, whereby we moved from lower-level codes to more abstract concepts that provide the foundation for developing an integrated theoretical scheme (Saldaña, 2009).

Third Round of Coding: Focus on Abstraction

Our coding allowed us to identify how actors reconceptualized the regulatory target in terms of the technology and its features (i.e., the technology's specific design), its uses, and its associated roles (i.e., the roles to be regulated). We noticed that, over time, the actors' understanding of these elements became more abstract—as a result of extracting common features and properties to identify the "common core or essence" of those elements (Kramer, 2007, p. 38)—and thus became more generally applicable. Therefore, we embarked on a third round of coding, where we focused on how actors developed an increasingly abstract understanding of the technology, its uses, and the associated roles. Key concepts around which we coded were *abstraction of materiality* (which later became abstraction of technology), *abstraction of use*, and *abstraction of roles*. At this point, we also detailed our understanding of the temporal development of how the actors made sense of the technology. Comparing the temporal development of events provided in the documents with what we learned from the interviews gave us insight into how the meaning associated with the technology evolved over time. We based our differentiation of phases on the actors who were involved in each phase, the start and end events, and the outcomes of those phases. We used time-ordered displays to describe the chronological flow of events (Miles et al., 2013) and how meaning associated with the project evolved over time. In so doing, we identified three key phases that relied on sensemaking around the emergent and equivocal technology: *closed-circle sensemaking* among the initial working group of six actors, *extended-circle sensemaking* to consider a broader variety of views, and *regulatory implementation*, including parliamentary debate and passage of the law. We identified the roles that the actors played in each phase and located how actors reconceptualized the technology in these phases. Table 4 shows how the documents we analyzed were distributed across the three phases.

Fourth Round of Coding: Further Unpacking Iterative Reconceptualizations

While we understood how the process unfolded over time, we needed to know more about how, specifically, actors reconceptualized the technology, so we recoded the documents, as they reflected the intermediate results from the sensemaking process and provided insight into the detailed changes in meaning that the working group and, later, the extended working group constructed. Some of these documents contained annotations and comments from the actors involved. For this exercise, we used tabular displays as well as visualizations to identify how the technology, its uses, and its associated roles were considered in each of the documents and to describe to the extent possible each reconceptualization in terms of the conceptualization before and after the reconceptualization as well as the underlying rationale. We analyzed how these developments were reflected in the law in its versions over time. This is also when we elevated elaboration—one salient element next to abstraction—to the level of a concept. While it had been clear since early in the analytical process that abstraction was accompanied by ongoing elaborations in the sense of specifying what mattered from a regulatory point of view, it was the detailed analysis of the conceptual understanding before reconceptualizing elements of the regulatory target and after reconceptualizing elements of the regulatory target that allowed us to highlight how specifically abstraction and elaboration constituted an iterative and intertwined process that produced reconceptualizations that led to two observed conceptual shifts that we describe in detail later. This is when we noticed that the collective prospective sensemaking we observed relied on the interrelated processes of abstraction and elaboration, which, over time, produced novel conceptualizations of the technology. We then also recoded the interviews with a focus on those elaborations. By corroborating the analysis of the documents using the findings from our interviews, we developed a detailed overview of the specific reconceptualizations that led to the two major conceptual shifts, each involving a number of interrelated abstractions and elaborations of the regulatory target.

[4] Making sense of materiality, making sense of use/potentials, and making sense of required regulation were the notions we used at this stage of the coding, but our final theoretical model distinguishes the level of technology, the level of use, and the level of roles. We used "making sense of regulation" early but then changed this code into "making sense of roles" because the regulatory statements that we heard from respondents and identified in the documents mainly addressed roles that were related to the technology. We used "making sense of materiality" to address how actors collectively made sense of the technology's material aspects but then changed this code into "making sense of technology" because we felt it appropriately captured the sensemaking that occurred around the technology in a narrower sense (blockchain, distributed ledger technology, trustworthy technology).

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Table 3. Emergent Categories and Example Codes

Emergent category	Example codes	Example quotations from participants
Making sense of use/potentials	Anticipating blockchain market potential	Assessing the market potential "is extremely difficult. I think that, to a large extent, if we speak about the financial sector, value generation will not significantly increase. The financial sector will adopt the new technologies to replace old ones" (Respondent 1).
	Anticipating blockchain use	"For industry, blockchain is mainly interesting in the area of supply chain management" (Respondent 3).

Table 4. Documents by Phase

Data	Phase 1: Closed circle sensemaking (Aug. 2016 –Aug. 2017)	Phase 2: Extended circle sensemaking (Sept. 2017–Aug. 2018)	Phase 3: Regulatory implementation (Sept. 2018–Dec. 2019)
Number of documents	10	23	21
Number of pages	176 (67 A4 pages, 109 PowerPoint Slides)	748 (608 A4 pages, 140 PowerPoint Slides)	1,050 (1,013 A4 pages, 37 PowerPoint Slides)

Theoretical Integration

As we moved through the coding process and identified concepts and developed further concepts, we constructed an increasingly coherent understanding of how the sensemaking process unfolded. Our lens of prospective sensemaking allowed us to integrate our findings theoretically by focusing on how meaning was created through a collective, discursive, and prospective process. We used textual and visual descriptions to iterate through the data, refine our understanding, move toward an integrated theoretical scheme, and arrive at an explanation of the regulatory process in terms of collective prospective sensemaking, relying on the processes of abstraction and elaboration that revolved around the technology, its uses, and its associated roles.

Case Description

The Context

In the second half of 2014, Liechtenstein's prime minister and the Ministry of General Government Affairs and Finance, launched an initiative, "Impuls Liechtenstein," to create an innovation-friendly context that would enable various sectors to create opportunities through institutionalized innovation processes ("impulses") and address the dynamics in the financial services sector that result from digitalization and increasing competition between geographic and political locations. One key element was so-called innovation clubs, where citizens could follow a formal application process to approach the Ministry of General Government Affairs and Finance with innovative ideas in a direct way. Innovation clubs were started for, among other things, topics related to digital finance, an e-currency institute, a framework for a cryptofinance system, regulation of virtual currencies in Liechtenstein, and a blockchain-based currency in Liechtenstein. These initiatives led to the foundation of the Regulatory Lab—a fintech competence center at the financial market authority—and, eventually, the core working group that was tasked with developing a regulatory framework for blockchain technology. Blockchain technology was a key topic for ideas proposed to the Ministry of General Government Affairs and Finance.

Our analysis suggests that the initiative had two central interrelated triggers: Regulatory demand and stakeholder interests. Regulatory demand occurred as stakeholders like industry representatives perceived that the existing regulatory framework did not address blockchain technology sufficiently, creating uncertainty about actions they may

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undertake. They demanded the construction of a regulatory framework that would allow them to act legitimately. In an interview, a government official said:[5]

> *Through our engagement with companies, we learned that they saw considerable uncertainty [regarding blockchain technology]. Imagine that, as a company, you wanted to implement a business idea, and this idea is so new that the current law does not tell you whether it is possible. You then start interpreting the law, and the government agencies also interpret the law, which creates uncertainty and inertia because everyone needs to think about how this new idea can be implemented.* (Respondent 15)

The absence of regulation began to play a practical role as business organizations sought to implement new business ideas around blockchain technology, but how they could gain legitimacy for novel business models remained unclear. Various stakeholders found potential uses and business models for the new technology that reflected their interests, and the government wanted to create jobs and a new branch of value creation around the new technology. In an interview, a representative of a regulatory agency said: "Eventually, the goal is to create something economically, to create jobs, to allow for the creation of value" (Respondent 1).

An interviewee who had deep knowledge about the crypto ecosystem highlighted how experiences from other countries made clear that a lack of regulatory framework could prevent projects from being executed:

> *I think that the topic was taken up because, in Switzerland, some projects could not be continued because the country's legal limits were reached and because some legal advisory in Switzerland was fully occupied, and people turned to alternative jurisdictional areas. … Then some projects came to Liechtenstein. … This raised a number of legal questions.* (Respondent 3)

Multiple stakeholders shared an interest in providing legitimacy and legal security for business models around blockchain technology. Against this background, with the support of the prime minister, six key experts in the fields of law, financial market supervision, government, industry, and technology formed a temporary working group to address the issue and develop a new regulatory framework.

[5] All quotations used in this paper from the interviews as well as the documents we analyzed (except the translation of the final legal text) are translated from German, the language spoken in the country we studied.

Key Phases

The process of making a blockchain law can be described as a sequence of interrelated phases (Langley, 1999) based on the occurrence of certain events (Abbott, 1990). We constructed a temporal order of how the case developed along three key phases: closed-circle sensemaking, extended-circle sensemaking, and regulatory implementation (Table 5).

Our analysis focuses on the first two stages, where the shared meaning that enabled the creation of a law that Parliament later passed was developed. However, we also considered the third stage, which occurred because of the preceding sensemaking process and completed our understanding of the overall conceptual development. We established these stages by identifying key activities and events, outcomes, and the actors involved. While these elements provide the foundation for a relatively clear-cut sequential process, the process within those phases was highly iterative, as key actors sought to create shared understanding and meaning. Still, making a law requires certain key elements, including a consultation process and certain formal steps when the law is brought before Parliament for passage.

Phase 1 (closed-circle sensemaking): Phase 1 started in the second half of 2016, when the Ministry of General Government Affairs and Finance, under the direct leadership of the prime minister, created a working group of six members who represented key perspectives. (See Table 1, some actors represented multiple perspectives.) The group of experts was tasked with developing a vision for cryptocurrency and blockchain technology that would help in creating a regulatory framework. The working group held four meetings and provided a sensemaking space where actors could reconcile their various perspectives, understand the many aspects of blockchain technology, and move toward a shared mental model. As the CEO of a blockchain start-up noted:

> *It started at a time when knowledge about blockchain was not widespread and each of us had different views …. We defined quite a lot … What is a token? How do we define a private key? How do we define a public key? This whole definitional part, which perhaps now reads relatively barren and sounds simplistic compared to today's knowledge, and writing all of this down, required hours of meetings and repeated starts and restarts only to define what a token is.* (Respondent 17)

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Table 5. Temporal Development, Key Events, Actors Involved, and Outcomes

	Phase 1: Closed-circle sensemaking	Phase 2: Extended-circle sensemaking	Phase 3: Regulatory implementation
Time frame	Aug. 2016–Aug. 2017	Sept. 2017–Aug. 2018	Sept. 2018–Dec. 2019
Key activities and events	The ministry recognizes a need for regulation of cryptocurrencies and blockchain manifested in a regulatory blockchain and cryptocurrency concept. (August 2016) Five meetings of the core working group explore regulation of cryptocurrencies and blockchain technology. (November 2016–April 2017) Over time, conceptual evolution from the regulation of cryptocurrencies and blockchain to the decision to make a law, manifested in a program about innovation and cryptofinance systems, takes place. (April 2017)	The government commissions a first draft of a report and proposal on a law on cryptofinance system. (November 2017) Prime minister announces law-making process in public speech. (March 2018) Working group is tasked with developing a law. (March 2018) Three meetings of an extended working group take place to address conceptual development of the report and proposal, the law and the consultation report, summarized in a protocol. (March 2018–May 2018)	Press conference and presentation of the law with the official start of the consultation report take place. (August 2018) Consultation and political lobbying related to the law begin. (August 2018) The government approves the proposal on the law for submission to Parliament. (May 2019) Results and start of legislative process in Parliament are communicated. (May 2019) Parliamentary debates and enactment of the law take place. (June and October 2019)
Key actors	Government, ministry, core working group	Government, ministry, extended working group	Ministry, government, Parliament
Key outcome	Concept for innovation and cryptofinancial systems (April 2017)	Consultation report on the law on trustworthy technology-based transaction systems (Blockchain Act; VT Act; VTG) (May 2018)	Law of 3 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG) (October 2019)

This process of collective sensemaking over an extended period was facilitated by two interrelated elements: the heterogeneity of perspectives and time to work outside day-to-day business. The heterogeneity of perspectives addressed the complex challenges involving business, legal, and technological issues, as various viewpoints could come together so sensemaking could occur at a collective level. As a respondent who represented the industry perspective and had in-depth knowledge of the regulatory context highlighted: "Good laws have originated from work in teams—people from the authorities and the economy, and perhaps some external consultants" (Respondent 3).

The working group also had time to work in a closed apolitical circle—members were from industry or did not have to follow political directives—which created a secure and stable space for them to embark on collective sensemaking:

> *In an early stage, you cannot discuss something with a mass of people … In the early stage, it is important to do this in a closed circle of good people …, innovative people, and then work it out to the extent that it constitutes a good solution among those people.* (Respondent 15)

This closed-circle setup does not mean that the representatives did not consider information from outside the circle but that they had the opportunity to work with a certain stability over a considerable period to form a shared mental model. This process resulted in a first proposal for a law for regulating a cryptofinance system based on blockchain technology.

Phase 2 (extended-circle sensemaking): Phase 2 commenced when additional experts with legal backgrounds and from academia were brought in to join the core working group,

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widening the group's expertise. Considering multiple perspectives throughout the process was a key element: "This worked because key stakeholders from industry were involved in the working group. I think that the ratio between lawyers and non-lawyers was balanced" (Respondent 12).

People from outside this temporary organization were also involved, such as the CEO of a Bitcoin company, who was not part of the working group but provided feedback and inputs early in the process: "Because we were always involved, we were able to give our feedback and inputs early" (Respondent 16).

The result of Phase 2 was conceptual development around regulating a trustworthy technology-based token economy and, eventually, a report on a law on trustworthy technology based on transaction systems to present to stakeholders for consultation.

Phase 3 (regulatory implementation): Phase 3 began with a press conference to announce the official start of the consultation process. The law was then presented to stakeholders to get their feedback, and the sensemaking process was carried outside the working group to involve more stakeholders:

> *The consultation is a formal process, so the government generates a report …. Then one has a defined number of weeks—in our case ten weeks, from mid-August to mid-November. Everyone had the opportunity to submit written comments. Throughout this phase, we communicated a lot, as we knew that the law was not easy to understand, and we considered all the inputs that were received formally or informally. We considered many highly substantial responses.* (Respondent 15)

The government started the political process and communicated the newly drafted law, the final version of the law after its passage, and a related ordinance to political parties, various stakeholders, and the general population from August 2018 to December 2019. After the two legally prescribed parliamentary readings in June and October 2019 and a detailed debate, the law was passed unanimously and came into force on January 1, 2020. An official press release highlighted how the law addressed both civil laws and the supervision of service providers, using the broad notion of the *token economy*. As the press release stated: "With the new law, Liechtenstein is the first country with a comprehensive regulation for the token economy. The law regulates civil law and also provides appropriate supervision of service providers in the token economy."

Thus, the process moved from a loose understanding of the need for regulation and a narrow understanding of the technology and its use, to the formation of a working group, to the extension of that working group, to an abstract and general conceptualization of technology and its uses that could eventually win public and parliamentary support.

Our analysis indicates that the sensemaking process involved a number of iterative reconceptualizations involving abstraction and elaboration that produced reconceptualizations that were iteratively articulated in various artifacts, including PowerPoint presentations, visualizations, concept papers, and the text of the law. These reconceptualizations involved an increasingly abstract, general, and effectively technology-neutral regulatory understanding that focused on the technology's uses in terms of secure storage and transfer of tokens and services around tokens; considered essential requirements for the technology in terms of ensuring the integrity, assignment, and disposal of tokens; and defined roles around the handling of tokens that would allow the technology to be regulated and provide an enforcement layer (e.g., through the role of a physical validator). Tokens were what Respondent 15 called the "crystallization point of the entire regulatory effort." Ultimately, the initial understanding of *token* as representing cryptocurrencies or other financial assets was replaced by the understanding that tokens were containers of rights, which also allowed functionality to be added to tokens.

Interrelated Abstractions and Elaborations Producing Conceptual Shifts

The idea of regulating cryptocurrencies and blockchain was promoted by actors who were functioning in the emerging crypto ecosystem, including Respondents 2, 11, and 13, the last of whom, for instance, had technical expertise in cryptocurrencies and blockchain technology. These actors represented the economic interest in regulating cryptocurrencies and blockchain, the focus on innovation using the new technology, and the requirement of legal certainty. In August 2016, goals expressed in a written regulatory concept for blockchain and cryptocurrencies based on discussions among the core working group members included the development of a concept for regulating the "blockchain industry" and a concept for "real value secured cryptocurrencies." Key notions used included "cryptocurrency," "virtual currency," and "blockchain." At this point, identified roles and their responsibilities that would be subject to such regulation included custodians (of tokens), wallet providers (software providers), trading platforms (that allow third parties to buy and sell), and exchange platforms (that act as interfaces between currency systems). These vaguely defined roles were specifically associated with cryptocurrencies and blockchain but already foreshadowed the first major conceptual development: towards regulating cryptofinance systems.

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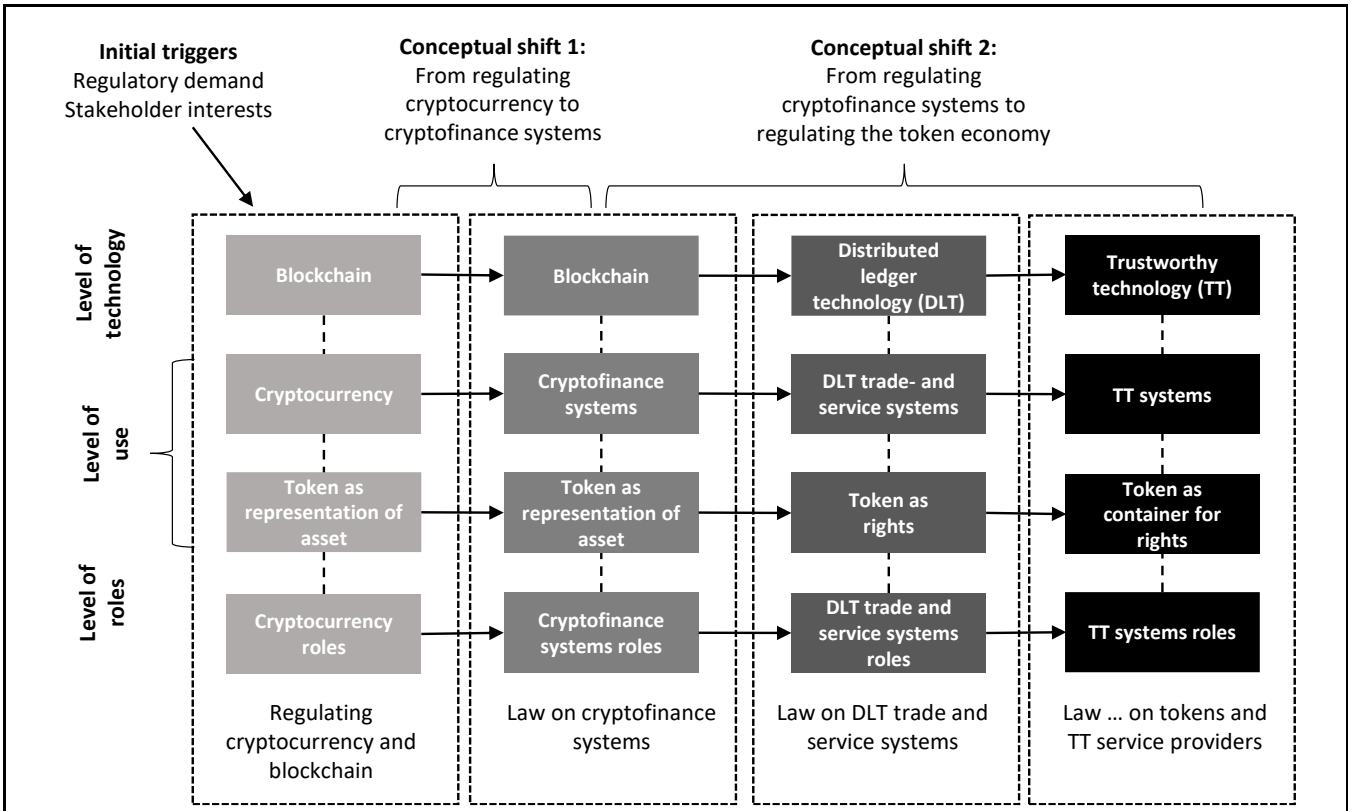

Figure 1. Conceptual Shifts and Underlying Reconceptualizations Based on Abstraction and Elaboration

Two key conceptual shifts—significant developments in the overall conceptual understanding of the regulatory effort along technology, use, and associated roles—departed from this initial understanding. The first shift was from the goal of regulating "blockchain for cryptocurrency" to regulating "blockchain for cryptofinance systems" and the second from the goal of regulating "blockchain for cryptofinance systems" to regulating "trustworthy technology for transaction systems and the token economy." We identified the more detailed reconceptualizations that occurred in terms of abstractions and elaborations for each of these two major conceptual shifts. Figure 1 provides an overview that highlights how the process was triggered by regulatory demand and stakeholder interests, how it comprised two overall conceptual shifts, and how these conceptual shifts are constituted by reconceptualizations regarding the technology (level of technology), potential uses (level of use), and associated roles (level of roles). These reconceptualizations reflect the outcomes of the interrelated processes of abstraction and elaboration collectively carried out by the involved actors.

Conceptual Shift 1: Blockchain for Cryptocurrency → Blockchain for Cryptofinance System[6]

Early in Phase 1 (closed-circle sensemaking), the focus was extended from the goal of regulating "cryptocurrency" like Bitcoin—which was a response to the triggers in terms of regulatory demand and stakeholder interests—to the more encompassing goal of regulating "cryptofinance." This elevated the regulatory effort to the systems level and required a conceptual description of the elements of cryptofinance systems. Respondent 15 suggested the idea of regulating cryptofinance systems.

This first major conceptual shift involved actors that represented a regulatory agency (Respondent 1), government (Respondent 15), crypto ecosystem and technical expertise (Respondent 17), and legal expertise (Respondent 3). Representation of these perspectives allowed the team to be receptive to developments in the external environment, as reflected in the emerging and equivocal nature of the technology, and provided impetus for the sensemaking

[6] Note that the timing of the shifts occurs in relation to but does not fully overlap with the three formal stages we identified.

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process. For instance, the regulatory agency confronted issues related to developments in the markets, such as an increasing number of initial coin offerings (ICOs) and discussions around the issuance of securities. These issues indicated that the focus on regulating currency was too narrow:

> *We started when the community was concerned with Bitcoin and Ethereum and the application of smart contracts, DAOs [decentralized autonomous organizations], etc. But then the ICO wave came, and we noticed that there were suddenly questions like "What is such a token?" and "Is it a security?" so the connection to the finance system became stronger. Before that, it was simply a cryptocurrency, but then it became more.* (Respondent 1)

At this stage, it was also important that a member who represented the government (Respondent 15) take the lead as an organizer and facilitator of the core working group that provided the sensemaking space in which the first concept was developed. The first conceptual shift involved mainly elaborations, as elements were added that provided a point of departure for further development of the law. However, it was already clear that regulating the emerging technology would require abstractions, mostly in relation to the roles that would have to be regulated. Table 6 provides an overview of the key reconceptualizations underlying the first shift and highlights how these reconceptualizations were produced by the interrelated processes of abstraction and elaboration.

Regarding the *use* of technology, the idea of regulating cryptofinance systems is more encompassing than the idea of regulating cryptocurrencies. The new notion of a "cryptofinance system," which was particularly promoted and developed by the government representative in the working group, who also wrote the first concept for regulating cryptofinance systems, can be traced back to December 2016. At this point, a cryptofinance system was seen as involving key objects, including identities (individuals and legal entities), digital assets (e.g., money, stocks, derivatives, raw materials, real estate), contracts, and structures (e.g., funds, trusts). A concept paper from January 2017 noted: "A cryptofinance system is based on the idea that digital assets are available for trade. Therefore, the transformation of physical assets to a digital representation is a central function."

This reconceptualization resulted from an elaboration of the required *roles*, which were further specified (e.g., the custodian must ensure that deposited assets are accessible at any time). A need for abstract role descriptions was documented in April 2017, early in the process, indicating the goal of abstraction. The government representative highlighted how finding abstract roles was a central element of the sensemaking process:

> *Finding these roles was elementary … and involved the effort not only to detach roles from the technology but also from business models. That was a general move throughout the process … from the specific use case to the abstract.* (Respondent 15)

Associated with this reconceptualization of the overall regulatory target was the insight that the goal was not only to establish a regulatory framework but also to do so in the form of a law. The intermediate result of the collective prospective sensemaking process can be seen in a label in a strategy document that was used to describe the intended outcome of the regulatory effort, which reflected the shared meaning in April 2017: the idea of a "law providing guidelines (*Rahmengesetz*) on cryptofinance systems." What later became the key element (the "essence") of the regulatory effort—tokens—was already present, and notions like "asset token" were used. However, at this point, "token" had no legal definition, and it was used in relation to the idea of a cryptofinance system in which tokens represented cryptocurrencies or other assets. That the goal was a technology-neutral regulation was already visible, but the focus was still on blockchain and so was specific to that technology.

Conceptual Shift 2: Regulating Cryptofinance Systems → Regulating the Token Economy

The second conceptual shift, which occurred in Phase 2 (extended-circle sensemaking), went from regulating cryptofinance systems to regulating the token economy. Awareness was increasing that blockchain and related technologies were facilitating the emergence of new business models, and from the perspective of regulation, the challenge was much more than regulating issues related to ICOs. One respondent highlighted this development: "Suddenly it was a Cambrian explosion, where many new lifeforms were created, and that needed to be accounted for" (Respondent 1).

Consequently, the sensemaking process moved away from its focus on financial applications, and the discussion came to be heavily influenced by actors who foregrounded the emerging nature of the technology from an industry (Respondent 17) as well as the legal perspective (Respondent 2), as they saw broad applicability to the economy and business models:

> *I see implications for the supply chains of all sectors—industry, logistics, administration. I see potential implications everywhere, particularly where the goal is to collaborate across companies and parties, and where digital goods … are transferred, exchanged, enriched, and transported.* (Respondent 17)

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Table 6. Key Reconceptualizations Based on Abstraction and Elaboration Underlying Shift 1

Reconceptualization	Level	Description
Cryptocurrency ⇩ Cryptofinance systems	Use	Through **elaboration**, the understanding of the use aspect of the regulatory target was reconceptualized from cryptocurrency to cryptofinance systems. The reconceptualization was based on elaboration because it involved the definition of elements that required consideration: identities, digital assets, and service providers.
Cryptocurrency roles ⇩ Cryptofinance systems roles	Roles	Through **elaboration**, the initial understanding of roles expressed in terms of cryptocurrency roles was reconceptualized to cryptofinance system roles. Roles were added and defined. There is also evidence of **abstraction** as part of this reconceptualization since the goal was to describe roles in abstract terms. Abstract role descriptions were considered a foundation for the regulation because they would enable the regulation of service providers rather than a specific technology.

The process was again facilitated by the government's representative (Respondent 15), who also facilitated communication with the government. Other actors were involved to help elaborate on the emerging text of the law—including academics who had a legal focus (Respondent 5 and Respondent 9)—and to reflect on the process and support the more specific formulation of the consultation report: "From March and April on, the focus was on specifying the consultation report further, especially the part concerning the regulatory law" (Respondent 5).

The second major conceptual shift involved abstraction and elaboration related to the technology, its uses, and its associated roles, which provided the groundwork for the concept of "token" as the essence of the regulatory effort in that the technology ensures the integrity of tokens, uses revolve around the secure transfer and storage of tokens, and roles provide services around tokens. The first set of interrelated reconceptualizations based on the interrelated processes of abstraction and elaboration underlying this shift occurred in February and March 2018 (Table 7).

Regarding the *technology*, we observed how actors abstracted from the focus on blockchain to the more general concept of distributed ledger technology (DLT), of which blockchain is just one potential implementation. DLTs are technologies that allow for the decentralization of data across data stores ("ledgers") and require some consensus mechanism to validate transactions. However, DLTs are less technology-specific than blockchain, which is a type of DLT that uses a particular type of data structure, where data is stored and transmitted in "blocks" that are connected to each other in a "chain" (Natarajan et al., 2017). The reconceptualization was mainly based on abstraction because blockchain is a type of DLT, so it shares all of its properties with DLT, whereas DLT shares with blockchain only some of its essential properties, such as decentralization and consensus-based validation. A document from February 2018 states that cryptofinance systems are based on DLT (e.g., blockchain). While the notion of a cryptofinance system was still used in this document, the *use* focus was soon also abstracted from "cryptofinance" to "trade and services." The notion of "trade and service systems" is more abstract and general than "cryptofinance," as the former addresses a broader variety of uses, as reflected in the focus on secure exchange (trade) and storage of tokens and associated services as a "system for the secure exchange (trade) and the secure storage of tokens and services based thereon." This involved a general token, whereas cryptocurrencies, for instance, are a specific type of token.

The understanding of token as being central to the regulatory effort had evolved. Accordingly, a February 2018 draft of the law text provided a legal definition of token, although this definition still considered elements of the technology and was not yet formulated in a technology-neutral way. It defined token as: "Information, consisting of a sequence of connected signs or bits. This sequence represents, through the use of a decentralized ledger, tradeable rights."

The understanding of *roles* evolved with the understanding of the technology and its uses, including the definition of a token. Roles were now defined in terms of DLT trade and service system roles and reflected a reconceptualization of the understanding of roles from financial roles to more general trade and service roles, which involved the formulation of roles for enforcement, including the role of a physical validator. Cryptocurrency-specific notions like "crypto safe provider" were dropped in favor of less specific, more abstract, and more generally applicable roles.

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Table 7. Key Reconceptualizations Based on Abstraction and Elaboration Underlying the First Part of Shift 2

Reconceptualization	Level	Description
Blockchain ⇩ DLT	Technology	The reconceptualization from the conceptual understanding of the technology target from blockchain to DLT was primarily based on **abstraction**, as it involved identifying essential properties of the technology (e.g., decentralization, consensus-based validation). Blockchain, a type of DLT, shares all of its properties with DLT, whereas DLT shares only some essential properties (e.g., decentralization and consensus-based validation) with blockchain.
Cryptofinance systems ⇩ DLT trade and service systems	Use	Through **abstraction**, the essential properties of the potential uses (trade and services related to tokens) were identified. Cryptofinance systems are a type of trade and service system but have specific currency-related properties, so they are closely related to DLT systems.
Token as representation of asset ⇩ Token as a right	Use	The reconceptualization from token as a (financial) asset to token as a right was based on **elaboration** as conceptual clarity was added through both definition and examples. However, we can also conceive of a "right" as being more abstract than an "asset"; thus, this reconceptualization also required **abstraction**.
Cryptofinance systems roles ⇩ DLT trade and service systems roles	Roles	Changing the focus from cryptofinance system roles to DLT trade and service system roles was based on **abstraction,** as cryptocurrency-specific notions (e.g., "crypto safe provider") were dropped, but also involved **elaboration**, as roles like the physical validator, which guarantees the enforcement of the rights represented by a token, were further defined.

The prime minister mentioned this more abstract and general understanding developed by the working group in a speech at the Finance Forum Liechtenstein conference in March 2018, still using the term "blockchain," which was a well-known term at the time: "Blockchain technology is interesting not only for cryptocurrencies like Bitcoin but also for other applications. In the future, next to cryptocurrencies, many other assets, such as real estate, cars, music titles, and bonds, will be traded on blockchain technology." The intermediate result of the collective prospective sensemaking process can be seen in the new title of the draft law text, "Law on DLT Trade and Service Systems," which reflected the shared meaning in February 2018.

Conceptual Shift 2, Continued: The Breakthrough in Terms of Trustworthy Technology and Token Container

DLT still pointed at aspects of implementation, although they were more abstract than "blockchain," so this conceptualization was not technology-neutral, as was also reflected in the understanding of token, which was still defined in terms of the underlying technology. The conceptual shift toward regulating the token economy involved additional abstractions that allowed the working group to move toward a more technologically neutral understanding and also involved additional elaborations. Table 8 provides an overview.

Regarding the *technology*, "trustworthy technology" (TT) replaced the concept of DLT, thereby omitting implementation details (abstraction) and providing a more encompassing understanding of the technology to be regulated, as DLTs were considered one form of trustworthy technology. We traced the documents' use of trustworthy technology to April 2018. The notion of "trustworthiness" describes a property of the technology that has the ability to create trust but does not relate to any specific type of implementation. The underlying rationale was that the technology would enable services that consumers can trust. As one respondent said: "This is about a story of trust—the consumer story in its broadest sense" (Respondent 1). Such an implementation-neutral formulation did not mean that technology does not matter, but the opposite:

> *And then I believe it will matter what these technologies are. We speak of "trustworthy technologies," but are they really, or will there be hacks and attacks … that could destroy that trust? How good are those technologies, really?* (Respondent 1).

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Table 8. Key Reconceptualizations Based on Abstraction and Elaboration Underlying the Second Part of Shift 2

Reconceptualization	Level	Description
DLT ⇩ Trustworthy technology	Technology	A reconceptualization from DLT, a type of trustworthy technology (TT), to TT was accomplished through **abstraction**. The essential property of the technology was seen in its abstract ability to create trust. However, the reconceptualization was also based on **elaboration**. The conceptual understanding of TT was changed from a technology that mathematically guarantees integrity of data and transactions to a technology that ensures integrity, clear assignment, and disposal of tokens.
DLT trade and service systems ⇩ Trustworthy technology systems	Use	Through **abstraction**, the understanding of the technology's use was reconceptualized from trade and service systems to TT systems. The essential use property was transactions around tokens. The reconceptualization went from DTL trade and service systems via TT trade and service systems (considering the abstraction in the technology) to TT transaction systems (transaction systems based on TT).
Token as a right ⇩ Token as a container of rights ("token container model")	Use	Through **elaboration**, the conceptual idea that tokens can represent any right or obligation or any collection of rights or obligations as well as associated functionalities, was developed further.
DLT trade and service systems roles ⇩ Trustworthy technology systems roles	Roles	Through **abstraction**, roles were reconceptualized from DLT trade and service system roles to TT system roles, thus removing the specific requirement of being related to DLT. However, since this reconceptualization also implied the need for further changes to the role descriptions, it also involved **elaboration**.

A document from April 2018 defined trustworthy technologies as "technologies that mathematically guarantee the integrity of data and transactions" and that "include a high level of trust-building elements." While no longer limited to "blockchain" or "distributed ledger," this definition of technology involves some details about implementation, as it prescribes that technology must "mathematically guarantee the integrity of data and transactions." However, this detail was abandoned later, thus completing the reconceptualization towards an abstract understanding of the technology, and the final law makes no mention of any "mathematical" guarantee but just that the technology must ensure the integrity of tokens. One respondent highlighted how this reconceptualization of trustworthy technology was a deliberate abstraction:

> *Trustworthy technology is the legal formulation, the wording, that we found in the end after seeking how one could describe the paradigm shift in such way that it did not have a specific reference. The move was from crypto to trustworthy technology, that is, an abstraction from the concrete technology for encryption to an abstract system that was entirely independent of cryptography.* (Respondent 15)

In the context of moving to trustworthy technology, the *use* focus was changed to "transaction systems" and the understanding of tokens was elaborated further. We traced this reconceptualization to June 2018, when a discussion addressed whether the law should be about "trade and service systems based on trustworthy technologies," "service providers based on trade and service systems based on trustworthy technologies," or "regulation of transaction systems based on trustworthy technologies." That "transaction systems" are an abstract conceptualization of the technology is mentioned in the explanations that precede a version of the law text from June 2018:

> *Because of the high pace of innovation around blockchain technology and its applications, it is important, to formulate a law that is sufficiently abstract to be applicable across technology generations. Therefore, in this law, the notion of "transaction systems based on trustworthy technologies (TT systems)" is used.*

The sensemaking around use kept the concept of token at its center. The participants still looked for an understanding of token that would capture what was now the broad application scope of the token economy:

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> *The complete opening for everything, this container of rights, happened then. We discussed what felt like 100 or 200 variants for how one could formulate this—first narrower and then wider—and toward the end it reached the quintessence, so we could cover all sorts of applications.* (Respondent 15)

The result of this process was a formulation of token that fully abstracted away from the technology that would handle those tokens; this was the breakthrough when the "essence" of the regulatory effort was detached from specific technological developments. The regulation was not about a specific technology but about tokens handled by trustworthy technologies, which were defined in May 2018 as follows: "An entry on the TT System that can embody justifiable claim or membership rights towards a person, rights to things or other absolute or relative rights and ensures assignment to one or more public keys." One of the respondents commented on the importance of tokens as the focus of the regulatory effort to develop

> *a law that now regulates tokens—because that is the central element—that allows market participants and investors who trade with tokens to get on board much more simply. So, I assume that this was one of the factors: that the application of the law is only then correctly delineated if tokens as central assignment units are regulated, and the focus is not so much on the network structure.* (Respondent 5).

The idea that eventually reflected the collective meaning that had been created and that helped convey the target of regulating service providers and their services based on trustworthy technologies using tokens, was that of a *token container*. This concept was the endpoint of the sensemaking process; it helped carry the idea outside the working group, explain it to a broader audience, and prepare the ground for discussing the concept in parliamentary debate. The notion of a token container did not find its way into the text of the final law but was a communication device used to capture the essence of the regulatory effort. The concept was thought to capture the idea that tokens could represent any right that could be "kept in" a token, which also requires the implementation of certain functionality associated with the connection between the token and the rights. Figure 2 shows the original visualization of the *token container model*.

This second conceptual shift led to the shared understanding that the regulatory effort in making a law focuses on the *roles* and associated services enabled by the abstract and general idea of trustworthy technology. At that point, the title of the law was "Law on Service Providers Based on Transaction Systems Based on Trustworthy Technology." The final title of the law, "Law of 3 October 2019 on Tokens and TT Service Providers," retains this technology element but also articulates that the regulatory target is trustworthy technology service providers (focus on roles) and the tokens they handle rather than the technology itself, which provides the foundation but is defined in an implementation-neutral way. Figure 3 shows Article 1 from the law, which indicates key elements in terms of use (transaction systems for tokens), the enabling technology (trustworthy technology as an implementation-neutral concept), the required roles (trustworthy technology service providers), and overall regulatory goals in terms of ensuring trust and being innovation friendly.

Discussion

Triggered by regulatory demand and stakeholder interests, sensemaking about an emerging and, therefore, necessarily equivocal technology to construct an innovation-friendly and technology-neutral regulation that creates legal certainty and protects users is based on the interrelated processes of abstraction and elaboration through which actors reconceptualize the regulatory target in terms of the technology, its uses, and its associated roles. This sensemaking must meet—or, rather, balance—two goals: First, it must find a conceptualization that can accommodate a variety of technology implementations, emerging uses, and role instantiations by omitting and extracting essential properties—it must abstract away from concrete technologies (Koops, 2006). More abstract formulations apply to a larger space of potential future instantiations and allow for generalization. This goal is met by means of *abstraction through which actors extract and generalize essential properties to reconceptualize their understanding iteratively on the way to formulating an innovation-friendly regulatory framework.* Reconceptualizing the regulatory target through abstraction transforms specific understandings of the technology, its uses, and its associated roles into more abstract understandings. Abstraction is the process of mapping one representation onto another by removing some features (Giunchiglia & Walsh, 1992), and allows one to focus attention on certain properties and to generalize in such way that identifies a target's "common core or essence" (Kramer, 2007, p. 38). Abstraction involves withdrawing and removing details, leaving out properties, and formulating more general concepts by extracting common features and properties from instances (Kramer, 2007). The process could also move toward a *less* abstract conceptual understanding (de-abstraction, moving from some abstract understanding of trustworthy technology to the idea that it would be desirable to regulate a technology with specific features). However, we did not observe such de-abstraction in the sense of narrowing the focus on more specific technologies in our analysis.

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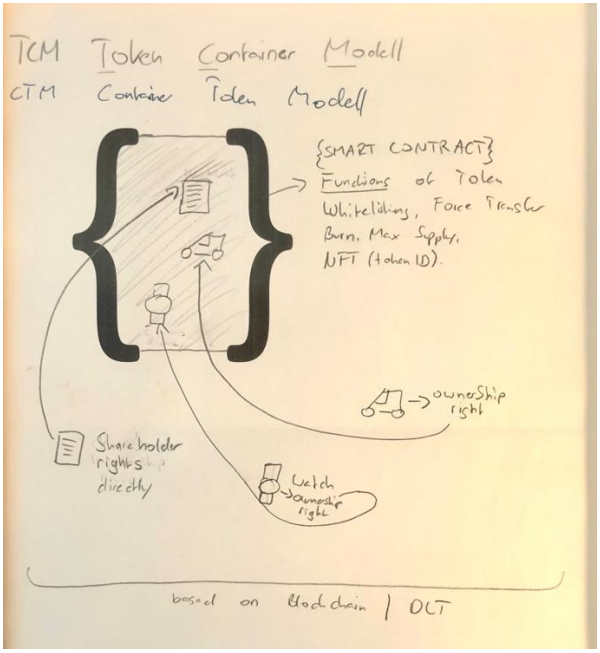

Note: Image provided by originator; for a description of the Token Container Model see also Nägele, T. (2022). *The Legal Nature of Tokens under Liechtenstein's TVTG with special consideration of the Token Container Model {T}*. DLT Media.

Figure 2. Original Visualization of the Token Container Model (September 2018)

Art. 1
Object and Purpose

1) This law establishes the legal framework for all transaction systems based on Trustworthy Technology and in particular governs:

a) The basis in terms of civil law with regard to Tokens and the representation of rights through Tokens and their transfer;

b) The supervision and rights and obligations of TT Service Providers.

2) It aims:

a) to ensure trust in digital legal communication, in particular in the financial and economic sector and the protection of users in TT Systems;

b) to create excellent, innovation-friendly and technology-neutral framework conditions for rendering services concerning TT Systems.

Note: The original version of the law is in German and this translation was provided for information purposes only (https://www.regierung.li/files/medienarchiv/950-6-01-09-2021-en.pdf)

Figure 3. Article 1 of the Law of 3 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG)

Second, sensemaking to regulate emerging technologies must identify and specify details and requirements that support the regulatory goals of creating legal certainty and protecting users (Koops, 2006). While the understanding of what is essential about the technology, its uses, and its associated roles is accomplished through abstraction, actors must work through these elements to make them amenable to regulation. This goal is met by means of *elaboration, through which actors identify and formulate details and requirements to reconceptualize their understanding iteratively on the way to formulating a coherent regulatory framework that also allows for control and enforcement.* Elaboration involves the incremental reformulation of elements of the regulatory effort, and elaborations of one element can require elaborations of other elements. Elaboration allows actors to refine their interpretations and integrate them into more complex shared mental models (Stigliani & Ravasi, 2012). By adding details and requirements and formulating a coherent conceptual understanding, elaboration supports the regulatory goals of creating legal certainty and protecting users.

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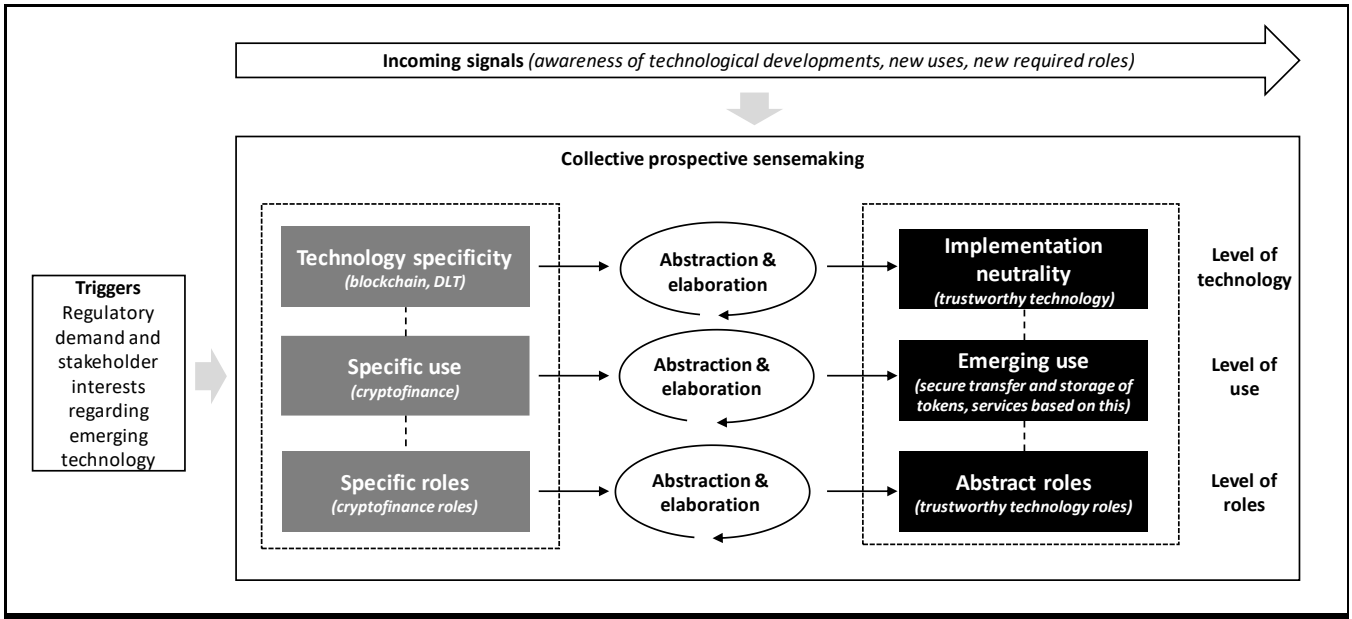

Figure 4. Process Model of Technology Regulation Through Prospective Sensemaking Based on Abstraction and Elaboration

Figure 4 visualizes this theorizing by highlighting how regulatory demand and stakeholder interests trigger a process of collective prospective sensemaking, in which the technology is reconceptualized using the interrelated processes of abstraction and elaboration. Through these processes, actors can move toward implementation neutrality, accommodation of emerging uses, and abstract roles. At the same time, abstraction and elaboration allow actors to reconcile their various viewpoints and consider incoming signals from the environment (e.g., in terms of technological developments and new uses) by increasing the level of abstraction while simultaneously specifying details and requirements relative to those levels of abstraction (e.g., in terms of the definition of roles).

At the *level of technology*, participants can use abstraction to construct conceptualizations that can accommodate future technological developments and implementations (Reed, 2007). Abstraction allows shared understanding to move from *technology specificity* to *implementation neutrality*. Implementation neutrality is one way to conceive of technology neutrality that highlights that multiple implementations of a technology are possible (Reed, 2007). Other ways to conceive of technology neutrality include *technology indifference*, which refers to an exclusive focus on ends and regulation that is independent of the technology, and *potential neutrality*, which refers to a focus on means such that, if at some point the regulation discriminates against some technologies, noncompliant technologies can be modified because the regulation does not impose specific technical standards (Reed, 2007). In the case we studied, the technology's essential property, identified through abstraction, was its ability to create trust (its trustworthiness). This property required a move from a focus on means (blockchain) to a focus on ends (trust). Many possible implementations of trustworthy technology—that is, implementations that have the essential property of being trustworthy as defined by the law—are possible. We use the notion of implementation neutrality to highlight that a law can allow for multiple implementations but is not completely indifferent to technology if the law articulates certain requirements (Reed, 2007). Unless a law is completely indifferent to technology, elaborations are needed around the abstract understanding of the technology to define its key properties. In our case study, elaboration helped add details and requirements in relation to the abstract property of trustworthiness, such as ensuring the integrity of tokens, their clear assignment to identifiers, and the disposal of tokens. These properties were further elaborated in an accompanying report that provided input for the parliamentary process and mentioned, for instance, specific potential implementations, such as through cryptography and decentralization.

At the *level of use*, abstraction can lead to conceptualizations that can accommodate future uses. Abstraction allows actors to move their shared understanding from *specific uses* that are known at the time of the law-making process to *emerging uses*, which can provide the legal basis for emerging business processes, business models, and services. In the case we studied, an abstract characterization of potential uses was

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conducted in terms of securely transferring and storing tokens as well as rendering services based on this. Elaboration was necessary to define the key characteristics of and requirements associated with those abstract uses. For instance, throughout the process, different "use cases" were discussed to elaborate how various roles would interact to allow for certain uses (such as uses around trading assets); this discussion helped in formulating the required roles.

At the *level of roles*, abstraction can move roles from *specific roles* to *abstract roles*, which is helpful for identifying what is essential about the roles to be regulated so they can be applied to a variety of situations. At the same time, elaboration is needed to define the relevant responsibilities and obligations and to make roles amenable to regulation and regulatory enforcement. In our case, we observed abstraction from roles that were specific to cryptofinance applications to roles like "token issuer" that were related to storing and transferring tokens securely and offering services around them. The key idea behind this abstraction was to ensure that all of these roles would handle tokens. This abstraction co-occurred with the formulation of role responsibilities and obligations, which involved, for instance, specifying the qualification of tokens and their disposal as well as the supervision of service providers in terms of registration requirements, reliability, technical suitability, minimal capital, and so forth. Thus, the regulation is more specific in terms of uses and roles than it is regarding the technology itself.

Implications for Research

Regulating Emerging Technology

We contribute to the literature on regulating emerging technologies (e.g., Brownsword et al., 2017; Butler et al., 2023; Kokshagina et al., 2023; Mandel, 2009; Székely et al., 2011)—or, more broadly, the literature on regulation in the context of sociotechnical change (Bennett Moses, 2017)—by focusing on the process of making sense of emerging technologies in order to regulate them, i.e., by focusing on the procedural instead of the substantive aspect of constructing regulatory institutions. Our focus is on the regulation *of* technology (e.g., Kokshagina et al., 2023) rather than *through* technology (e.g., De Vaujany et al., 2018; also see Butler et al., 2023). We highlight how actors *abstract* to extract and generalize essential properties in support of the regulatory goals of technology neutrality and innovation-friendliness and *elaborate* to identify and specify the details and requirements supporting the regulatory goals of creating legal certainty and protecting users. We thus explain how collectives of actors involved in technology regulation balance potential trade-offs between abstracting away from specific implementations while also providing clarity and precision (Koops, 2006). We contribute to clarifying several aspects of the process of regulating emerging technologies, which we elaborate on in what follows.

New technologies and their associated capabilities raise regulatory questions (Bennett Moses, 2017) and create regulatory gaps (Mandel, 2009) that lead to ambiguity, thus triggering regulatory processes and institutional change. Such was the case with Bitcoin and Ethereum, which raised questions about blockchain regulation (Finck, 2018; Kiviat, 2015) and have recently been featured in debates and political processes around regulating generative AI (Hacker et al., 2023). One important issue triggering these processes is the ambiguity that stakeholders experience in relation to the materiality (e.g., unclear understanding of the materiality of blockchain) and uses (e.g., discussion around what blockchain allows for) of a novel technology, as well as its associated consequences and risks. The ensuing sensemaking process may involve an influx of signals as the regulatory process progresses and actors co-create meaning as the technological development proceeds. While regulators make sense of the technology, other actors in the environment also make sense of the technology and develop new processes, products, and business models, which must be reflected in the regulatory process. Our model of the interrelated processes of abstraction and elaboration explains how, beginning with initial triggering signals, actors conceptualize (they need to start somewhere) and then reconceptualize technology to construct shared meaning, and how this process involves accommodating an influx of signals as technological development progresses. To further increase our understanding of how regulatory processes evolve, future research could study when those reconceptualizations occur, what causes them to occur, and why the result is formalized in a new regulatory institution, such as a written regulation or, as in our case, a law.

One key element of the sensemaking process as it moves from a triggering event to passing a regulation is the level of specificity versus neutrality of the regulated technology or class of technologies. Technology neutrality has been criticized because of its imprecision (Bennett Moses, 2017; Koops, 2006; Reed, 2007) and because it does not pay sufficient attention to the sociotechnical context of technology deployment (Bennett Moses, 2017). For instance, Bennett Moses (2017) argued that technology specificity may not be best suited to achieving some regulatory goals but that the technology itself and its particular procedures and properties should, in some cases, be the regulatory target. The point is that the underlying technology *does matter*. Therefore, the role of technology and the extent to which it needs to be specified is necessarily subject to the sensemaking process. Our study supports the notion that technology specificity and technology neutrality can be conceived of as a continuum rather than a dichotomy and that regulating emerging

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technologies thus need not entail a choice between dual poles of specificity and neutrality (Greenberg, 2015). Actors move along the continuum through collective sensemaking, reconceptualizing the regulatory target through abstraction and elaboration. This process reflects that most regulations involve both technology-specific and technology-neutral elements (Bennett Moses, 2017; Greenberg, 2015). To further improve the understanding of how technology-specific and technology-neutral elements are combined in technology regulation, future research could study the circumstances under which actors decide to add technology-specific elements or technology-neutral elements.

The movement from specificity to neutrality does not involve changes in the understanding of the technology's material aspects alone. Our theorizing views questions about implementation specificity versus neutrality as being directly related to the dimensions of specific use versus emergent use and specific roles versus abstract roles; thus, it views the regulation of emerging technologies as an inherently sociotechnical problem. This view is consistent with the perspective that the challenge is related more to adjusting laws and regulations for sociotechnical change than regulating technologies (Bennett Moses, 2017). Regulation must consider the evolution of the sociotechnical context through the stream of new capabilities enabled by the new technology (Bennett Moses, 2017). Our work contributes to this debate by providing a nuanced perspective on how technology is conceptualized throughout the regulatory development process. This nuanced view characterizes technology neutrality from a sociotechnical perspective that departs from a primarily artifact-centric understanding of technology neutrality and moves toward one that puts what it is that matters about the technology in the foreground (Leonardi, 2012). We highlight that the conceptualization of the technology, its uses, and its associated roles all involve some conceptual understanding of the technology: The technology dimension captures the technology's material aspects; the use dimension, rooted in some material understanding, captures what it is that can be done with the technology; and the role dimension captures how actors are involved in those uses or appropriations through the actors' institutional roles. Any change in the understanding of the technology's level of abstraction involves a reconceptualization not only of the technology itself but also of its emerging uses and associated roles. To further develop our understanding of technology regulation as a sociotechnical problem, future research could study the more specific mechanisms that link change in one sociotechnical dimension to the other dimensions in terms of regulatory efforts.

Finally, the relational perspective allows us to explain how shifts from an initial focus on a specific technology to a focus on its uses and the regulation of its associated roles can occur, as the regulation of emerging technologies typically focuses on behaviors and outcomes (Greenberg, 2015; Koops, 2006; Reed, 2007), while regulatory design should focus on consequences (Wiener, 2004). Choosing a certain level of abstraction and then elaborating on the essential properties at that level facilitates thinking about uses and roles in terms of responsibilities and obligations, thus defining policy goals in terms of behaviors and outcomes. In our study, we observed an increasing elaboration of roles, which then constituted the core of the lawmaking effort and reflected the notion that those who seek to regulate emerging technologies must understand them as being embedded in a complex and changing sociotechnical context (Bennett Moses, 2017). To further improve our understanding of a moving regulatory focus, future research could address how specific moves from more technology-centric to more outcome-oriented conceptualizations occur—and, perhaps, vice versa.

This perspective can be applied to other technology regulation efforts. For instance, the EU regulatory framework proposal on AI defines AI technologies not in terms of their functionality or material features but in terms of the risks associated with what can be done with those technologies. The goal involves "to promote the uptake of AI and address the risks associated with certain uses of this new technology" (Madiega, 2023, p. 2). For instance, AI technologies that can be used to exploit vulnerable groups are perceived as posing an unacceptable risk, whereas AI technologies that can be used in education and vocational training are perceived as posing "only" a high risk (Madiega, 2023). One could use our framework to analyze how this process has considered increasingly abstract or increasingly specific understandings of technology over time, as the theory of regulating emerging technologies through the interrelated processes of abstraction and elaboration that we present in this paper suggests that moving in both directions—specificity and abstraction—may be possible.

Making Sense of Emerging Technology

Emerging technologies like blockchain are associated with uncertainty and ambiguity (Rotolo et al., 2015) and involve new ways of using those technologies (Reed, 2007; Rotolo et al., 2015; Yoo et al., 2012), new business models, and new modes of value creation (von Briel et al., 2018). They are characterized by equivocality because they allow for multiple and sometimes conflicting interpretations (Berente et al., 2011; Weick, 1990). Our study extends work on sensemaking around digital technologies (Berente et al., 2011; Gattringer et al., 2021; Gephart, 2004; Weick & Meader, 1993) in three ways.

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First, we highlight the sociotechnical focus (Sarker et al., 2019) of sensemaking around emerging technologies by describing it as a discursive process (Stigliani & Ravasi, 2012) that unfolds simultaneously through iterative reconceptualizations that consider technical aspects of the technology, its potential uses, and its associated roles. The case we studied always featured the understanding that all three elements must be considered because they are interrelated, and changes in the understanding of one element would require changes in the others. That is, while we can detail the iterative reconceptualizations through abstraction and elaboration along three dimensions, reconceptualizations in one dimension are always in relation to the conceptual understanding of the other dimensions, highlighting the relational aspect of sensemaking around technologies (Mesgari & Okoli, 2019). Through this process, actors can place certain elements in the foreground or the background. In the case of making a law, the conceptual development of roles, including their obligations and responsibilities, is placed in the foreground. Future research could study this phenomenon in relation to other emerging technologies and explore the diachronic aspect of how sense is made over time (Rotolo et al., 2015) and how prominence is given to certain elements of a technology.

The second way in which our study extends work on sensemaking around digital technologies is that our case suggests viewing sensemaking around emerging technologies in terms of identifying the "essence" of a technology. This essence is a *construction*, as it represents what those involved in the sensemaking process agree are the essential properties of a technology that falls under the legal provision. The essence of a technology is an abstract idea that represents qualities that are shared by particular (or less abstract) things, which Locke (1847) refers to as "nominal" or "abstracted" essence (as opposed to "real essence," the individual constitution that makes a thing what it is). Therefore, since the essence of a technology relates to those who were involved in the sensemaking process, it may change over time and across legal contexts and may even change its level of abstraction to pertain to more or fewer instances or instances that share other characteristics.

In the case we studied, for example, "trustworthiness" represents a central idea related to the *integrity of tokens*, which comprises an aspect of the essence of the technology. However, someone observing what actors considered essential about the technology at an earlier stage in the sensemaking process might have thought that using distributed ledgers to keep data was the essence of the technology. However, the sensemaking process involving abstraction and elaboration made explicit what really mattered about the technology (Leonardi, 2012), changing the group's understanding of the technology's essence. From a sociotechnical perspective, the essence is a conceptual idea that allows a technology's aspects in terms of the technology itself, its uses, and its associated roles to be tied together. Future research could focus on how collaborative sensemaking leads to identifying the essence of digital and emerging technologies, including AI. For instance, the European Parliament (2023b) conceives of AI as "the ability of a machine to display human-like capabilities such as reasoning, learning, planning and creativity," which gives us a sense of the essence of that technology from its point of view.

Third, we highlight how the interrelated processes of abstraction and elaboration allow actors to create shared, collective meaning despite the equivocal nature of technology. As both abstraction and elaboration begin *from* some understanding and move *to* some other understanding, retaining the properties of the technology, its uses, and its associated roles that actors collectively identify as important or essential is possible. Abstraction—and the identification of a technology's essence—allows for a variety of perspectives around the dimensions of the technology's materiality, uses, and roles to be accommodated. Elaboration helps make the abstract understanding tangible—and, in our case, amenable to regulation—and links the elements of the regulatory outcome in terms of the technology, its uses, and its associated roles. Future research could study the roles of abstraction and elaboration in overcoming inaction and engaging in collective action in the context of institutional construction, even when actors' individual interests do not necessarily favor cooperation (Wijen & Ansari, 2007).

Implications for Practice

To navigate the process of regulating emerging technologies using multiple perspectives, we suggest that regulators should increase and (conceivably) also decrease their level of abstraction regarding regulatory targets and shift emphasis among the various perspectives. That is, regulators should navigate a solution space that is comprised of multiple levels of abstraction and specificity across the interrelated dimensions of technology, its uses, and its associated roles. Changes in one element of the conceptual understanding are associated with changes in other elements. Our findings can thus support "policy entrepreneurs" (Wiener, 2004) in their construction of innovative regulations.

Increasing the level of abstraction can help to accommodate multiple perspectives, create consensus, and construct shared meaning. Therefore, we suggest that actors who are involved in the regulatory process should consider abstraction and elaboration in their sensemaking around the technology. While abstraction can address the need to

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increase innovation friendliness, elaboration can address the need for regulatory specificity and integration to facilitate enforcement. While our study highlights a move from a specific technology to a more abstract understanding of technology, reducing the level of abstraction and thus narrowing the boundaries of the class of technologies that fall under the provision could also be a strategy.

Shifting the focus from one dimension—e.g., technology—to another can help shift the focus from regulating technology to adjusting laws and regulations for sociotechnical change (Bennett Moses, 2017), that is, to elements that are relevant in the face of sociotechnical change. For instance, focusing on the outcomes that certain material aspects of a technology may produce can help regulators think about how the broader legal context—laws and regulations—can accommodate new capabilities or practices or how that context should be adjusted (Bennett Moses, 2017).

Finally, this more nuanced understanding of moving between implementation specificity and neutrality, specific uses and emergent uses, and specific roles and abstract roles can help address key problems with the lack of precision of the concept of technology neutrality (Bennett Moses, 2017; Koops, 2006; Reed, 2007). These problems include those of prediction, as regulation is made with the current technology in mind; penumbra, which refers to uncertainty about how a regulation actually applies; perspective, which focuses on the use that a technology facilitates versus the design that enables that use; and pretense, which refers to the fact that technology neutrality is based on judgment calls that may, for instance, exclude future developments (Greenberg, 2015). This sociotechnical perspective allows regulators to consider specific social contexts, such as the specific uses of the technology's deployment (Nissenbaum, 2004; Pfaffinger, 2022). Therefore, abstraction and elaboration are mechanisms by which actors who are involved in regulatory efforts can move between general applicability and context specificity and decide on a level of abstraction that is sufficiently innovation friendly but that also provides the specificity required for regulations to be effective and enforceable.

Limitations

We examined one case in a small state. While Liechtenstein shares key regulatory elements with larger states, larger institutional systems are likely to require different processes and more and different kinds of actors. We also did not consider the entire process but mostly focused on the sensemaking element that was involved in constructing the regulatory framework before it was debated in Parliament and eventually took force. Future research could extend this perspective by analyzing the interactions that occur when a legislature rejects a regulation, requires it to be revised, and so on. To address these limitations, we related our study to the existing literature and used existing concepts whenever possible so that we could generalize from the idiosyncratic detail of our study (Orlikowski, 1993) and move to the level of formal concepts (Urquhart et al., 2010), including sensemaking practices.

Conclusion

Our analysis highlights how prospective sensemaking around emerging technologies relies on the role of the interrelated processes of abstraction and elaboration in identifying what it is that matters about a technology (abstraction) and the details, requirements, and explanations that support the regulatory goals of creating legal certainty and protecting users (elaboration). Balancing specificity and abstraction across the dimensions of technology, uses, and associated roles could address some of the criticisms of technology-neutral regulation and facilitate institutional construction around emerging technologies.

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