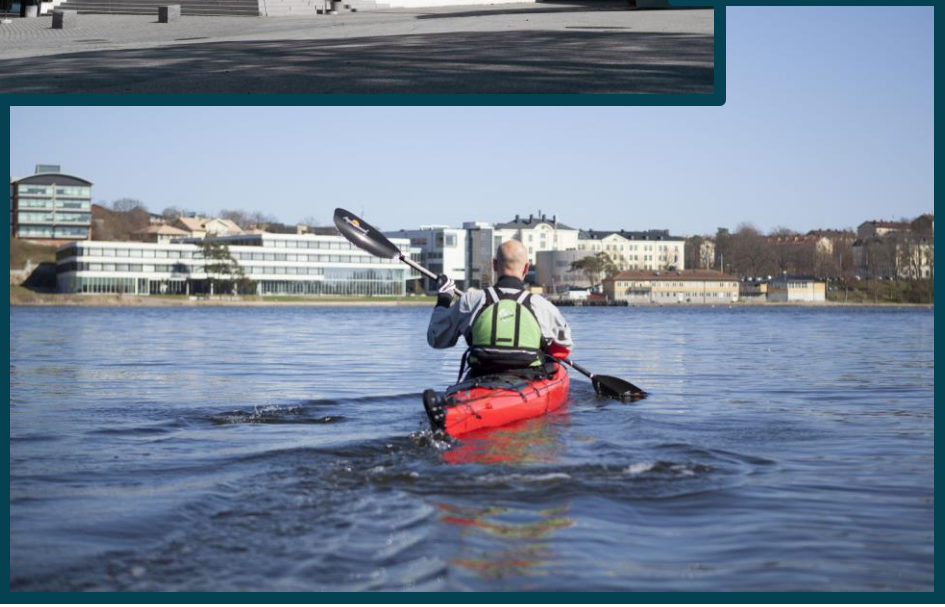
AI for Regulatory Requirements Engineering in Fintech: Challenges, Insights, and Future Directions

Michael Unterkalmsteiner
michael.unterkalmsteiner@bth.se

FutureFinTech, March 13, 2025

Blekinge Institute of Technology



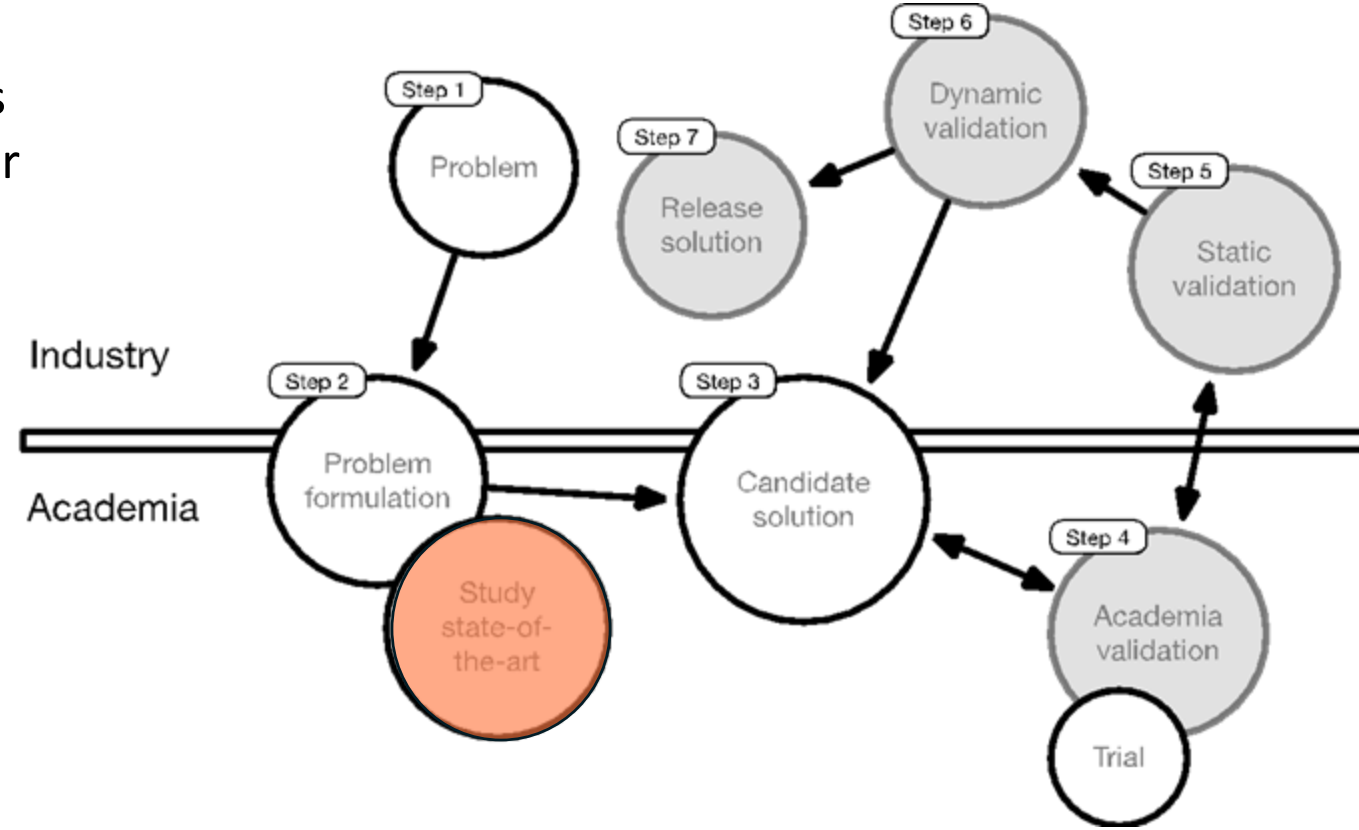
A smörgåsbord of Regulatory Requirements Engineering

- Research approach
- State-of-Art
  - Challenges
  - Opportunities
- State-of-Practice
  - Regulation analysis
  - Regulatory impact analysis
- Outlook

Smörgåsbord = Buffet. Figuratively, an abundant and diverse collection of things.

Our co-production research approach

- Continuous exchange and evaluation as basis for effective research and technology transfer
- Ensure practical relevance of research
- Adopted as standard for empirical software engineering research



T. Gorschek and D. Mendez. Solving Problems or Enabling Problem-Solving? From Purity in Empirical Software Engineering to Effective Co-Production
https://link.springer.com/chapter/10.1007/978-3-030-65854-0_9

State-of-art in Regulatory Requirements Engineering

RQ1: What are the reported challenges in regulatory compliance of SIPS?

RQ2: What are the principles and practices (PPs) used to address regulatory requirements challenges?

RQ3: Which stakeholders were involved in the development of PPs for regulatory compliance of SIPS?

RQ4: What are the main software processes areas (PAs) involved in enabling the regulatory compliance of SIPS?

RQ5: Which regulations and domains of application are most considered in regulatory compliance of SIPS?

Regulatory compliance: the state of verifiable adherence to public, general, obligatory norms specified in regulations

***Software-intensive products and services (SIPS)*:** any products and services in which software components contribute to the design, construction, deployment, and evolution of the system as a whole or make an essential contribution to the added value of products and services.

Principles and practices (PPs): are any means employed to implement regulatory compliance of SIPS and to tackle the related challenges. These include but are not limited to SE methods, tools, frameworks, solutions, and models.

Kosenkov, O., Elahidoost, P., Gorschek, T., Fischbach, J., Mendez, D., Unterkalmsteiner, M., Fucci,D. & Mohanani, R. (2024). Systematic mapping study on requirements engineering for regulatory compliance of software systems. *Information and Software Technology*, 107622.

Scope of the review

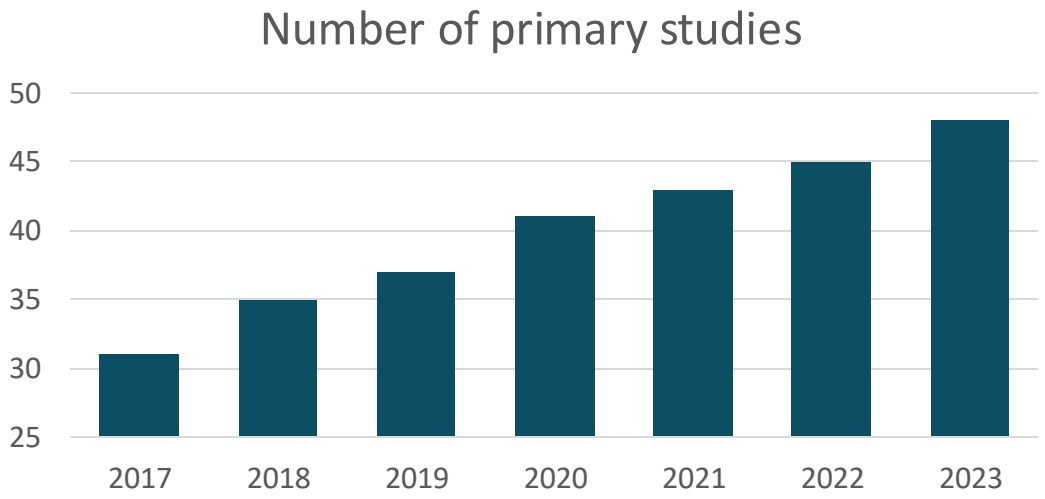
Search string

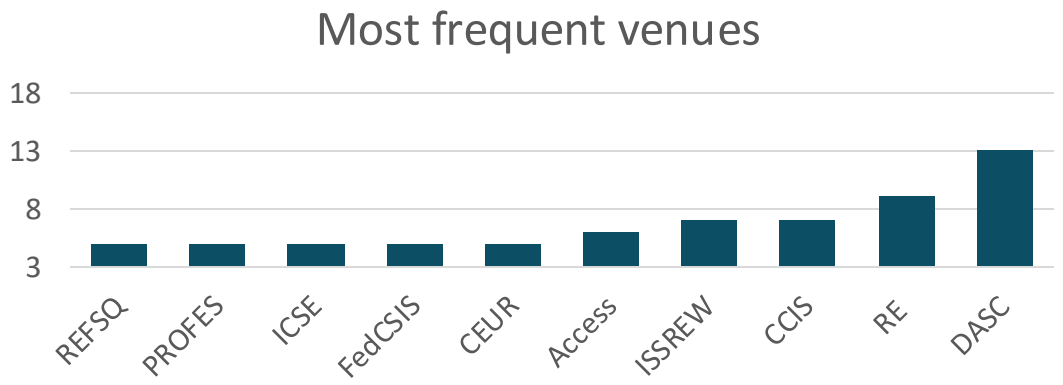
```
software AND requirement AND
(regulation OR regulatory OR
compliance OR law OR legal OR
certification)
```

2017-2023

280 primary studies

181 unique publication venues



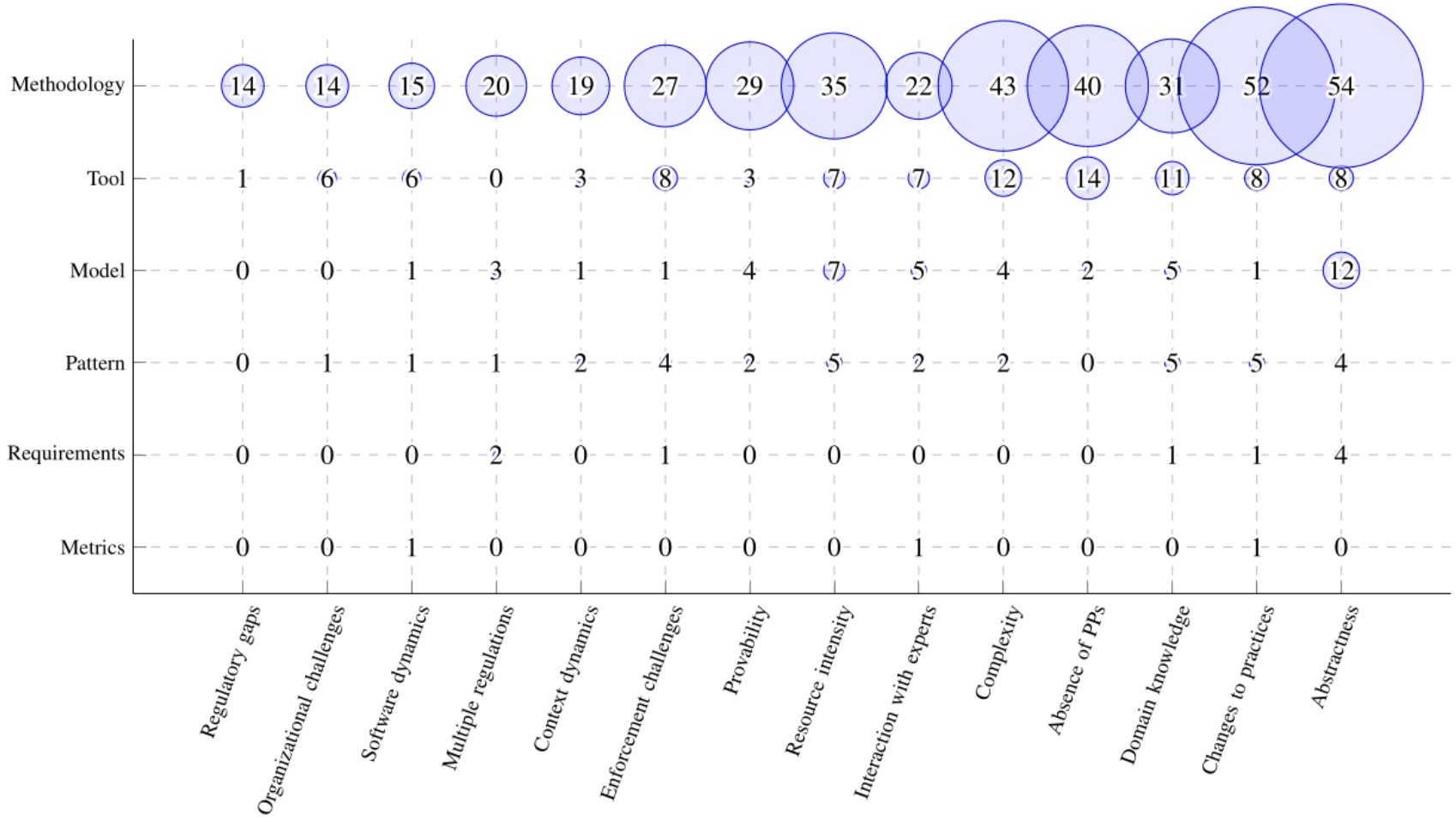


RQ1: What are the reported challenges in regulatory compliance of SIPS?

Challenge category	Frequency	Example
Abstractness of regulations	96	“They find that the requirements of the standard are expressed at a high level.”
Conflicts/changes to existing practices	84	“Certain DO-178C objectives make it difficult to reuse software previously developed out of DO-178C context.”
Demand for domain/legal knowledge	72	“SMEs can face the challenges with insufficient knowledge about regulations and standards”
Absence of principles and practices	71	“Previously introduced methods still lack efficient means for the representation of attacker motivation and have no prescribed way of constructing attack scenarios.”
Complexity	69	“The resultant legal requirements models usually contain the complexities inherited from the original texts.”

Interaction with experts (58), Resource intensity (58), Provability (55), Enforcement challenges (52), Dynamics of software context (37), Multiplicity of regulations (35), Dynamics of software systems (33), Organizational challenges (29), Regulatory gaps (26)

RQ2: What are the principles and practices used to address regulatory requirements challenges?



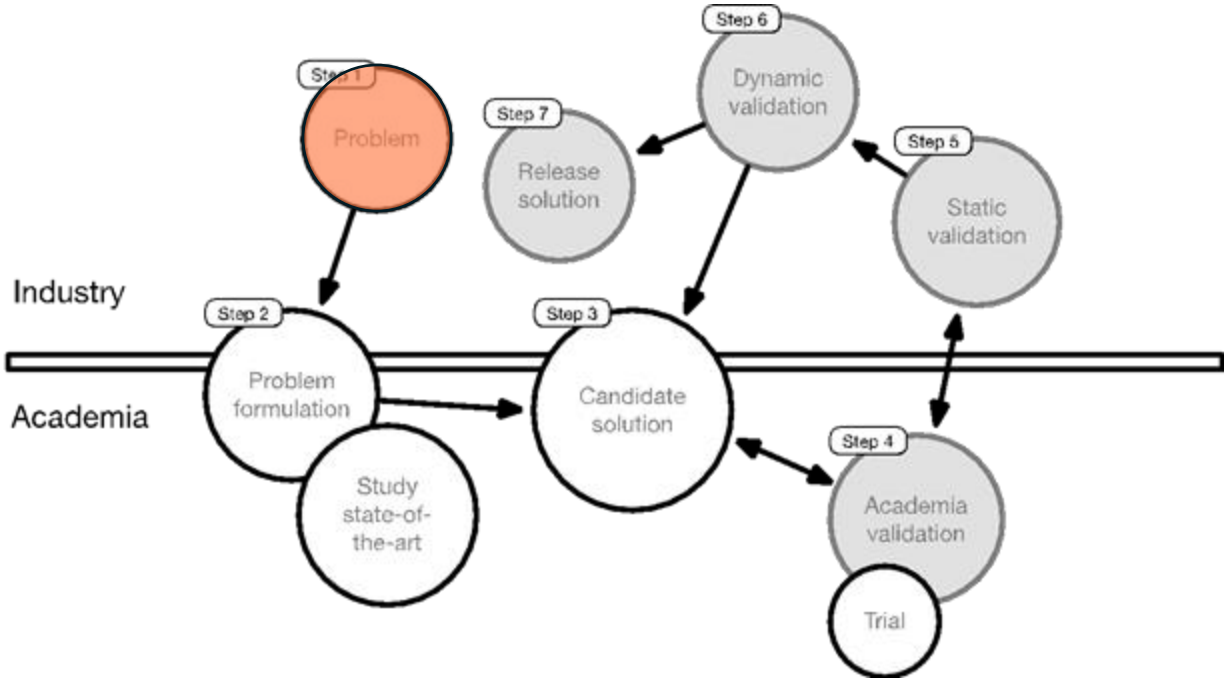
State-of-art: key take-ways

- Regulatory RE is multi-faceted
  - Importance of interaction of legal, domain and technical experts
  - Regulation independent approaches are rare
- Emphasis on methodology, little tool support
  - Open question what tasks can be automated to support Regulatory RE ***and do work in practice***
- The study provides an excellent and comprehensive (between 2017-2023) review of the field

State-of-practice

Two case studies:

1. **Inferring requirements:** understanding how regulations need to be implemented in products
2. **Regulatory impact analysis:** understanding how regulations affect enterprise decisions



State-of-practice: inferring requirements from regulations

Goal: Explore software engineering practices and challenges with regulatory requirements, identify constraints and opportunities within a medium-sized FinTech enterprise, and establish the groundwork for a future approach that accommodates these limitations.

- **RQ1:** What are the engineering practices when working with requirements with regulations as a source?
- **RQ2:** What are the associated challenges encountered by software engineering teams when working with requirements stemming from regulations?
- **RQ3:** How can the tool support ease engineering activities, highlighted by the identified challenges?

Elahidoost, P., Mendez, D., Unterkalmsteiner, M., Fischbach, J., Feiler, C., & Streit, J. (2024, June). Practices, Challenges, and Opportunities When Inferring Requirements From Regulations in the FinTech Sector-An Industrial Study. In *2024 IEEE 32nd International Requirements Engineering Conference Workshops (REW)* (pp. 137-145). IEEE.

Project overview

Project A	Banking	2013 - present	Investment Tax Act & Common Reporting Standards
Project B	Banking	2013 - present	FACTA, Communications Handbook & Law on the automatic exchange of information about financial accounts in tax matters
Project C	Insurance	2014 - present	GoBD & Code of conduct by insurance companies
Project D	Public service	2016 - present	Data exchange with social insurance

RQ1 engineering practices when working with requirements with regulation as a source

1. **Understanding and Interpretation**
   - Engineers translate legal jargon into technical specifications.
   - Business analysts and domain experts collaborate to derive and interpret requirements.
2. **Creation of Supplementary Documentation and Artifacts**
   - Which need to be maintained and traced to
3. **Collaboration with Domain Experts**
   - Continuous interaction with client's domain experts.
4. **Testing for Compliance**
   - Emphasis on rigorous testing, including regression testing.
   - Case D: Highlights the importance of regression testing for different tariff variants.
5. **Feedback and Certification**
   - Involves external auditing bodies for certification.

RQ2 Challenges encountered by software engineering teams when working with requirements with regulations as a source

Interpretative and Communication Challenges

- **Difficulty in interpreting complex regulations**
- **Communication gaps between domain experts and developers**: Limited information available beyond the regulation (communication handbook)

Technical and Process-Oriented Challenges

- **Late changes in regulations:** Try to foresee the future and the regulations to implement the correct specification on time (e.g. generating the tax certificate)
- Ensuring thorough **testing and verification** for compliance: regression testing, especially when dealing with repetitive changes
- Maintaining **detailed and up-to-date documentation** to streamline these processes: Tracing code changes and understanding their purpose or link to requirements
- **Change impact analysis when new tariffs or changes occur**

RQ3 Potential of tool-supported approaches to address some of the identified challenges

Document Comparison	**An ideal tool would go beyond basic page-by-page comparison, discerning alterations in phrasing and semantics.**
Test Case Generation	**This is especially valuable when regulations are frequently updated**
Update Notifications	**Creating an automated system to notify developers of regulatory changes affecting their projects ensures timely updates.**
Traceability	**Implementing tools that provide traceability from requirements to implementation simplifies managing changes and their impact.**

State-of-practice: regulatory impact analysis

European Accessibility Act (EAA) establishes EU-wide accessibility requirements for products and services.

EAA timeline:
April 2019 – took effect
June 2022 – national legislation enacted
June 2025 – need to be implemented for new products and services

Products

- Computers and operating systems
- Smartphones and other communication devices
- TV equipment related to digital television services
- ATMs and payment terminals (e.g., card payment machines i supermarkets)
- E-readers
- Ticketing and check-in machines

Services

- Phone services
- Banking services
- E-commerce
- Websites, mobile services, electronic tickets and all sources o information for air, bus, rail and waterborne transport services
- E-books
- Access to Audio-visual media services (AVMS)
- Calls to the European emergency number 112

Kosenkov, O., Unterkalmsteiner, M., Mendez, D., & Fischbach, J. (2024, November). Regulatory Requirements Engineering in Large Enterprises: An Interview Study on the European Accessibility Act. In *International Conference on Product-Focused Software Process Improvement* (pp. 204-220). Cham: Springer Nature Switzerland.

Research Questions

RQ 1: How do large enterprises conduct Regulatory Impact Analysis (RIA) for the EAA?

RQ 2: What are the challenges to RIA?

Methodology:
Three group semi-structured interviews with nine experts involved in the RIA process in three large enterprises.

	Enterprise 1 (E1)	Enterprise 2 (E2)	Enterprise 3 (E3)
Industry	Telecommunications	Finances	Finances
Employees	>15,000	>10,000	>15,000
Countries present in	7	7	4(8)
Agile methodology	SAFe	SAFe	SAFe
Interviewees	Enterprise architect Enterprise architect Legal expert	Accessibility expert Technical expert Legal expert	Customer experience expert UI design expert Accesibility expert
Interviews duration	2.3 h	1.5 + 1.5 h	1 + 1.3 h

RQ1: How do large enterprises conduct Regulatory Impact Analysis for the EAA?

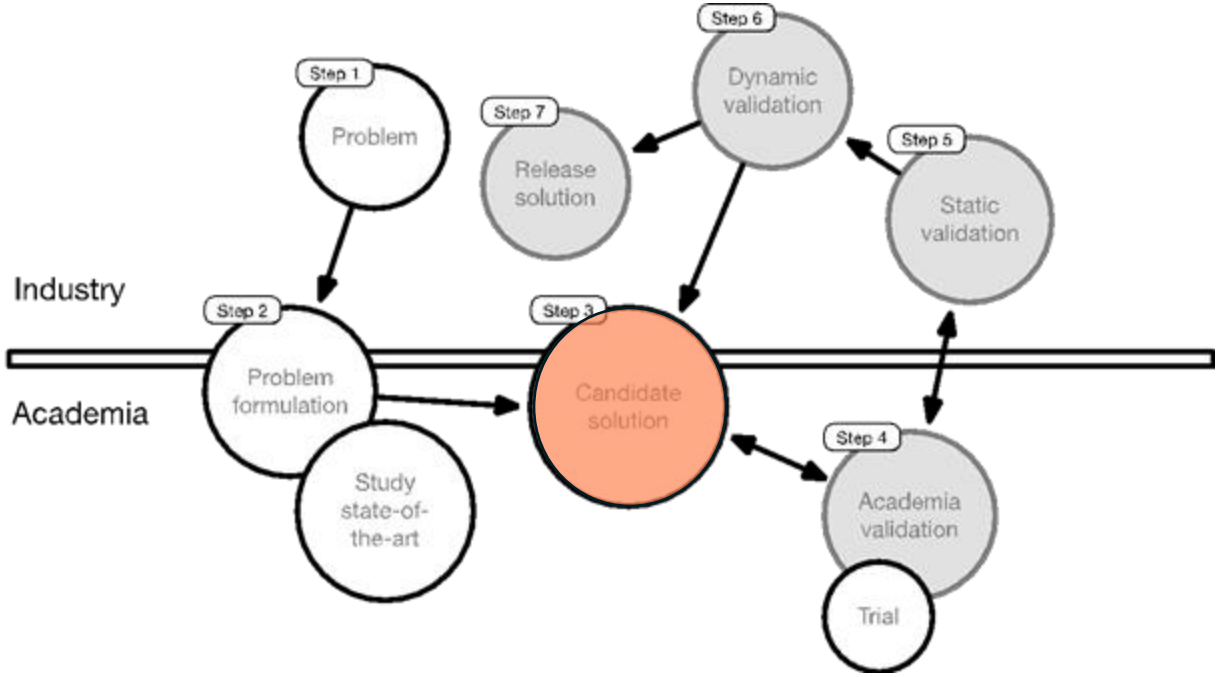
- Analysis of regulatory artifacts (legal experts in RIA group)
- EAA applicability analysis (RIA group; organizational units/product teams)
- Gap identification (RIA group; organizational unit/product teams)
- Measures identification (RIA group for enterprise-wide measures; organizational unit/product teams for their level)
- Impact assessment (RIA group for enterprise-wide measures; organizational unit/product teams for their level)

State-of-practice: key take-aways

Both studies, at different levels, exhibited **gaps** in effectively supporting practitioners in:

1. Capturing and reusing domain/legal expertise in downstream SE tasks
2. Performing change analysis (know when to act on what)
3. Assessing state of compliance at all points in time and across products and services

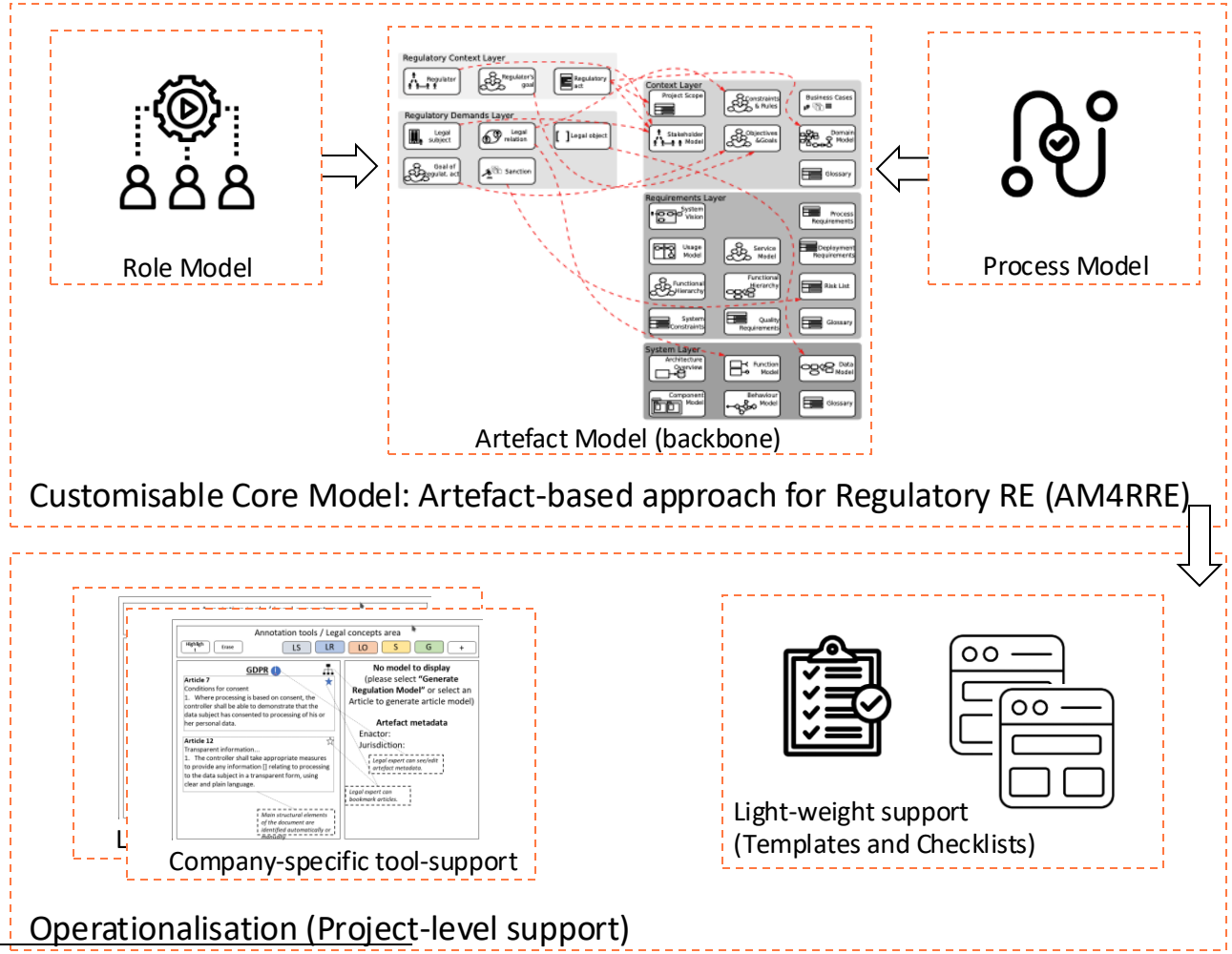
Outlook



OpenAI. (2025). *Steampunk-style looking glass* [AI-generated image]. DALL·E.

Artifact-driven Regulatory RE

- Conceptual Model: Extension of AMDiRE (SOTA model for RE) for Regulatory RE
- Focus so far: GDPR
- Operationalisation 2-fold
  - Light-weight support via templates and checklists based on artefact model
  - Software tool to support legal experts capturing (translating) legal texts



Kosenkov, O., Unterkalmsteiner, M., Mendez, D., Fucci, D., Gorschek, T., & Fischbach, J. (2024, June). On developing an artifact-based approach to regulatory requirements engineering. In *2024 IEEE 32nd International Requirements Engineering Conference Workshops (REW)* (pp. 262-271). IEEE.

Manage regulatory and requirements changes

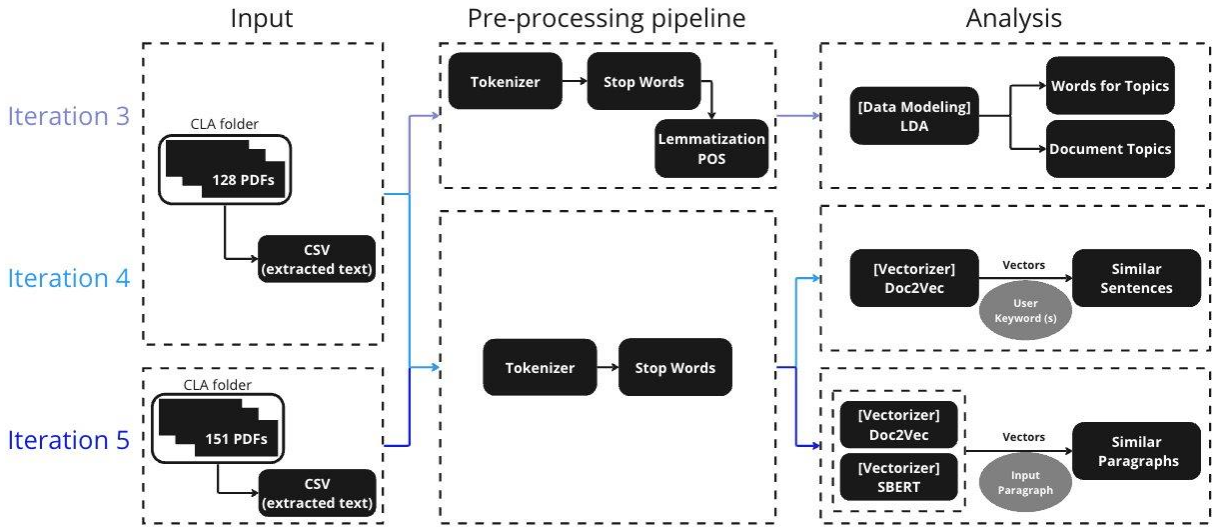
Goal: To develop a semi-automated approach to help engineers **manage regulatory changes** efficiently and ensure critical updates are not overlooked.

Focus Areas:

- Develop systematic methods to classify and manage regulatory changes.
- Address key challenges:
  - Change detection
  - Impact analysis

Done so far:

- Created and validated a change categorization framework through workshops and interviews
- Identified critical change types:
  - procedural, data/field, and editorial.
- Explored NLP and LLM tools for detecting and categorizing changes.



Overall take-away messages

- Regulatory RE is a (very) broad, inter-disciplinary research area
- Plenty of challenges in practice which require:
  - Deep understanding of "pain points" necessary to design support (methodological, technological)
  - Technical solutions need to go hand-in-hand with process changes

Thanks to the Team!

Kosenkov, O., Elahidoost, P., Gorschek, T., Fischbach, J., Mendez, D., Unterkalmsteiner, M., Fucci,D. & Mohanani, R. (2024). Systematic mapping study on requirements engineering for regulatory compliance of software systems. *Information and Software Technology*, 107622.

Elahidoost, P., Mendez, D., Unterkalmsteiner, M., Fischbach, J., Feiler, C., & Streit, J. (2024, June). Practices, Challenges, and Opportunities When Inferring Requirements From Regulations in the FinTech Sector-An Industrial Study. In *2024 IEEE 32nd International Requirements Engineering Conference Workshops (REW)* (pp. 137-145). IEEE.

Elahidoost, P., Unterkalmsteiner, M., Fucci, D., Liljenberg, P., & Fischbach, J. (2024, March). Designing NLP-based solutions for requirements variability management: experiences from a design science study at Visma. In *International Working Conference on Requirements Engineering: Foundation for Software Quality* (pp. 191-204). Springer.

Kosenkov, O., Unterkalmsteiner, M., Mendez, D., & Fischbach, J. (2024, November). Regulatory Requirements Engineering in Large Enterprises: An Interview Study on the European Accessibility Act. In *International Conference on Product-Focused Software Process Improvement* (pp. 204-220). Springer.

Kosenkov, O., Unterkalmsteiner, M., Mendez, D., Fucci, D., Gorschek, T., & Fischbach, J. (2024, June). On developing an artifact-based approach to regulatory requirements engineering. In *2024 IEEE 32nd International Requirements Engineering Conference Workshops (REW)* (pp. 262-271). IEEE.

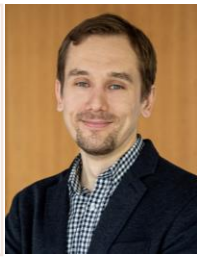
Angermeir, F., Fischbach, J., Moyón, F., & Mendez, D. (2024, October). Towards Automated Continuous Security Compliance. In *Proceedings of the 18th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement* (pp. 440-446).

Parisa Elahidoost
PhD Student

Tool-supported impact analysis of requirements in response to changing regulations

Oleksandr Kosenkov
PhD Student

Regulatory requirements compliance of software-intensive systems



Florian Angermeir
PhD Student

Requirements and Verification, Security, Automation

Jannik Fischbach
Post-doct. researcher

Requirements quality and automation via natural-language processing

Tony Gorschek
Professor

Software/Requirements Engineering and Quality Management

Daniel Mendez
Professor

Software/Requirements Engineering and Quality Management

Follow our work:
https://lmsteiner.com/publications.html

Get in touch:
michael.unterkalmsteiner@bth.se

IST special issue on

Regulatory Compliance in Software Engineering

Guest Editors: Sallam Abualhaija, Michael Unterkalmsteiner, Daniel Mendez

Submission deadline: September 5, 2025

Questions: reg.compliance.in.se@gmail.com


BLEKINGE TEKNISKA HÖGSKOLA
BTH