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Challenges in supporting the creation of data minable regulatory codes: a literature review

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Context and motivation

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The Application of Just In Time Tracing to Regulatory Codes and Standards

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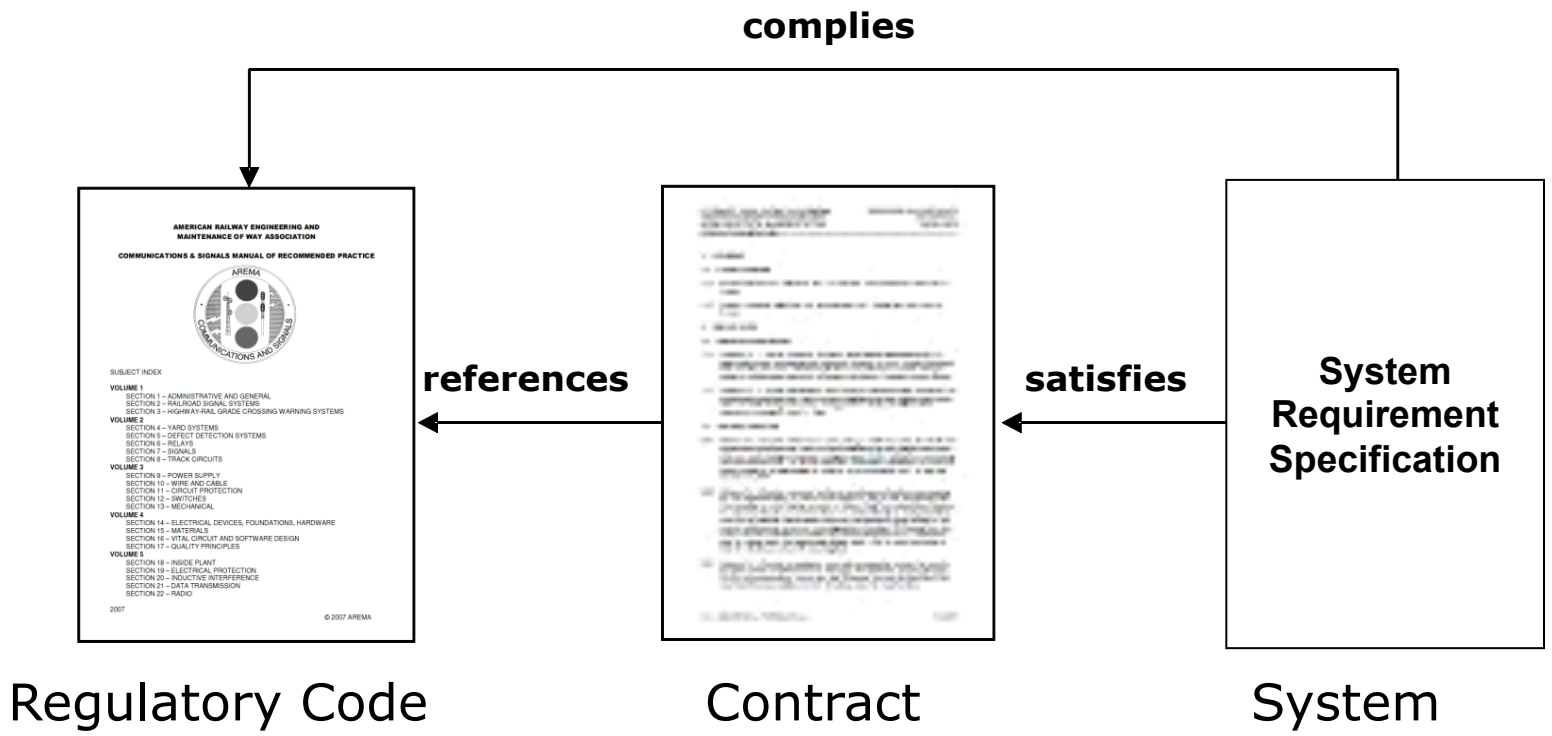
Presented to the Conference on Systems Engineering Research 2010

The Holy Grail of Compliance Processes



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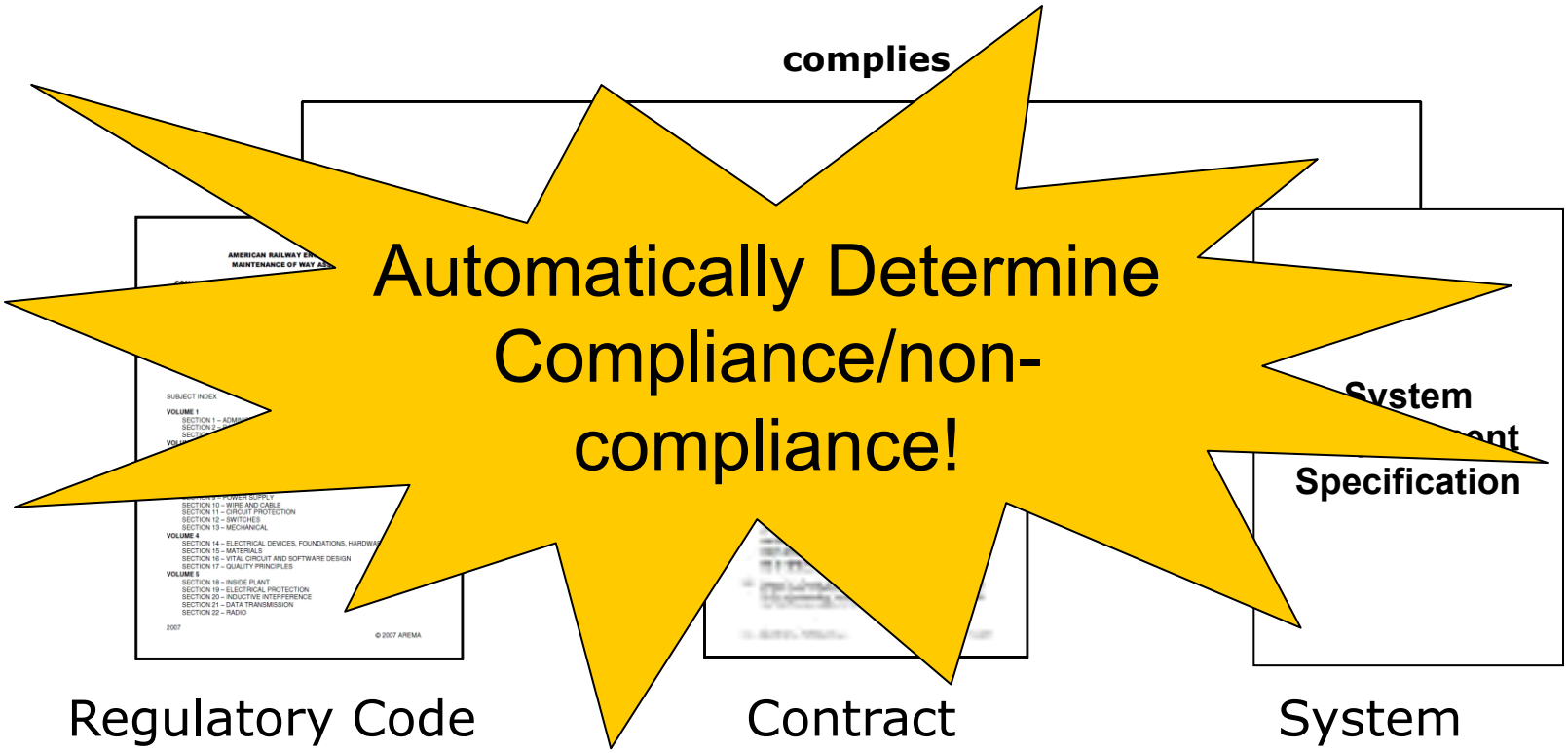

Context and motivation

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- Establishing and maintaining traceability in large projects is a challenging task
- Traceability is a way of providing the evidence of compliance with various regulations, regulatory codes and standards
- Standards and regulatory codes are issued by third party organizations and committees
- The result is that the project organization can neither control the content of all standards that the projects should adhere to, nor negotiate or make changes to them that can make the project development easier.

Example of regulatory compliance

AREMA® C&S Manual

2004 **Part 12.6.10**

3. Rail-mounted components should preferably be provided with a means to clamp to the rail base rather than bolt directly to the web of the rail, or should be tie-mounted.

4. Where bolt holes are required in the web of the rail, hole diameter required should, where practicable, be 0.375 in. Holes should not exceed 0.55 in. in diameter. Holes should be drilled such that the hole center line is on or within 0.5 in. of the neutral axis of the rail.

5. Track-mounted components should not cause the rails to become grounded or shorted together.

6. Track-mounted components should not interfere with or be adversely affected by track circuits or cab signal systems and, where possible, should not carry the track circuit around a broken rail.

satisfies

2.4.3.3 Ductwork shall not interfere with track circuits and, where possible, shall not carry the track circuit around a broken rail.

More context and motivation

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- Large infrastructure projects require compliance with hundreds of standards of regulations coming from different agencies, with different styles and structures,
- Some of them exceeding 1000 pages per a single regulatory code
- Regulatory requirements contribute to the challenging growth of complexity in the system engineering automotive development
- Fricke and Schultz[1] mention that system development is facing rapidly changing environments in markets, competition, technology, regulatory and societal systems
- The better the market and regulatory environment is understood the more likely the organization can concisely write and correctly interpret stable product requirements

1. Schulz, A.P.; Fricke, E.; , "Incorporating flexibility, agility, robustness, and adaptability within the design of integrated systems - key to success?," Digital Avionics Systems Conference, 1999. Proceedings. 18th , vol.1/17 pp. vol.1, no., pp.1.A.2-1-1.A.2-8 vol.1, Nov 1999

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Organizations with Regulatory Codes impacting a single Project!

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturers Association
AMCA	Air Movement / Control Association International, Inc.
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CAN	Canada National Standard
CanLII	Canadian Legal Information Institute
CGSB	Canadian General Standards Board
CSA	Canadian Standard Association
CWC	Canadian Wood Council
EEMAC	Electrical Equipment Manufacturers Association of Canada
FM	Factory Manual
IEEE	Institute of Electrical and Electronic Engineers, Inc.
IESNA	Illuminating Engineering Society of North America
ISO	International Organization for Standardization
MIL	Military Specifications and Standards
MOE	Ontario Ministry of the Environment
NEMA	National Electric Manufacturers Association
NFPA	National Fire Protection Association
OPSS	Ontario Provincial Standard Specification
RSIC	Reinforcing Steel Institute of Canada
SAE	Society of automotive engineering
SMACNA	Sheet Metal and Air Conditioning Contractor´s National Association
TIA	Telecommunications Industry Association
TT	Toronto Transportation
UL	Underwriters Laboratories

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Challenge studied

- We explored a new approach to tackle the problem of tracing regulatory codes and standards in large industrial projects.
- That is, providing guidelines for writing standards and regulatory codes that can be later made data minable in an efficient manner.
- In this paper, we report findings from an exhaustive literature survey that reveals that this area of research has not yet been explored.

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Research goals

The goal of the literature survey was twofold:

- Search for reported evidence in studies about traceability between various types of requirements and regulations, codes and legal documents

- Search for reported evidence in studies about providing unified models and standards for writing regulatory codes and legal documents that can be more easily searched and data mined

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Research method

The literature survey has been conducted using a hybrid approach where we combined three methods for searching the literature:

(1) experts' opinion,
(2) database searching and
(3) reading titles and abstracts

We conducted a pre-study literature review to gain an overview of the terminology in the field of regulations, law and legal requirements as well as find some relevant papers that can serve as a starting point for the survey.

The pre-study was done on papers from the requirements engineering literature

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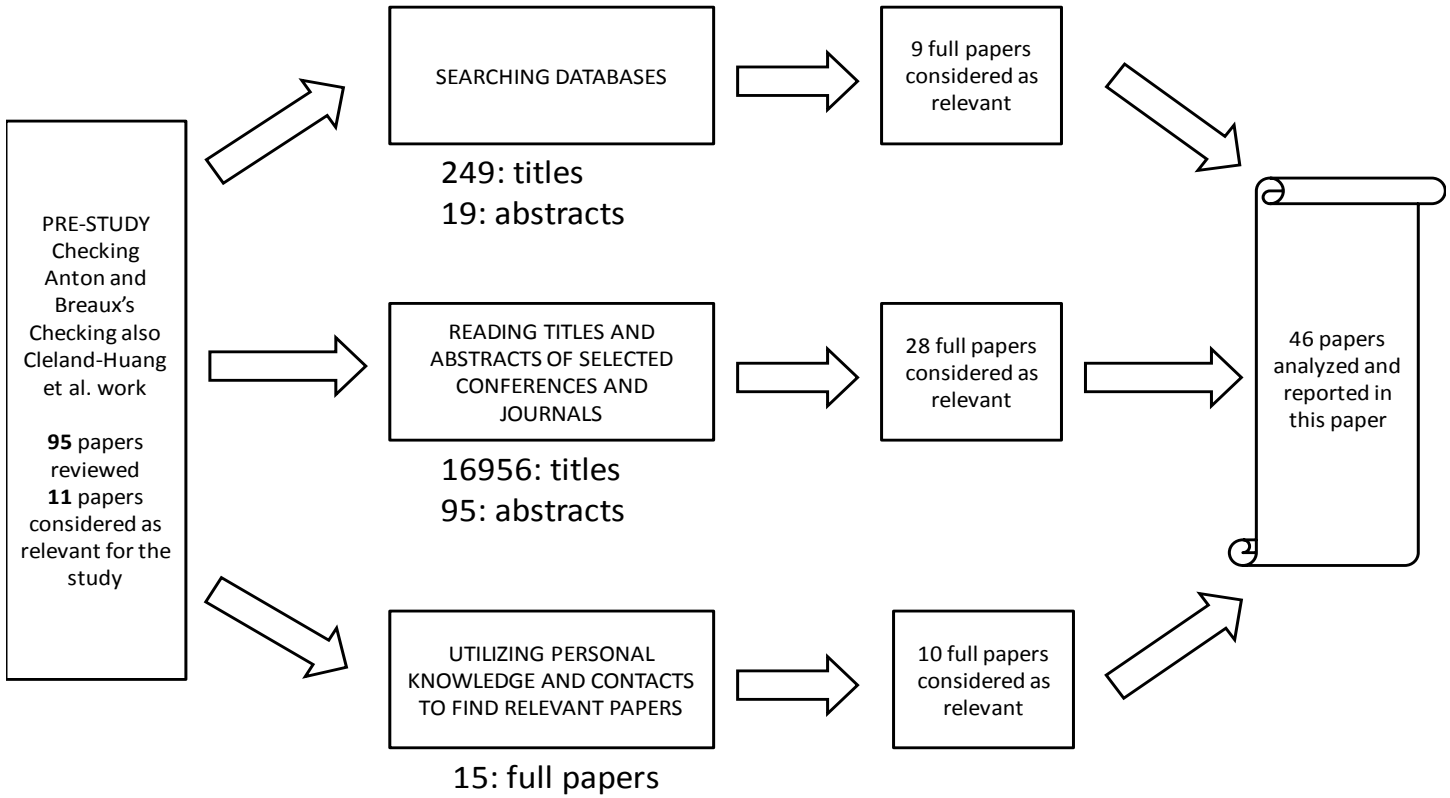
Research process



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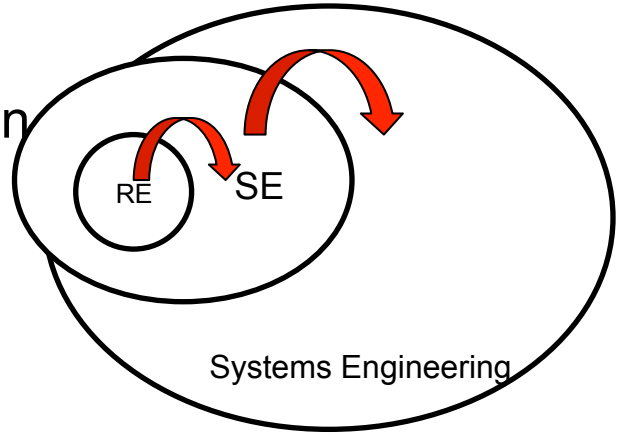
Purpose and results of the pre-study

The goals:

(1) to gain an overview of the terminology in the field of regulations,
(2) find some relevant papers that can serve as a starting point for the survey

We worked from RE to SE and the SysE domain



We included over 70 peer-reviewed papers where 3 were selected for full reading and one book chapter was also selected for full reading

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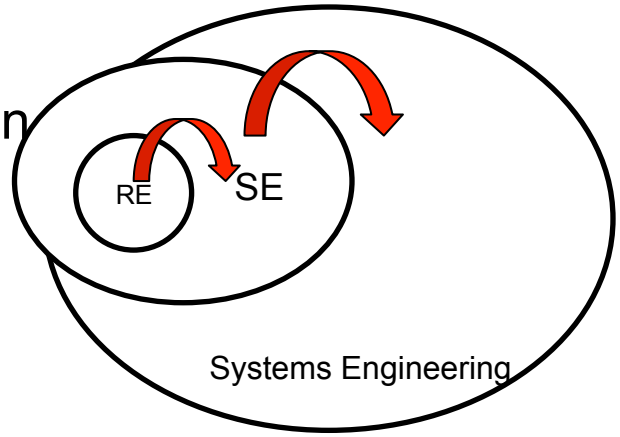

We included over 70 peer-reviewed papers where 3 were selected for full reading and one book chapter was also selected for full reading

RESULT → 11 PAPERS CONSIDERED AS MAYBE RELEVANT !!!

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Searching databases

We searched the following databases:

- (1) Inspec, which indexes IEEE publications,
- (2) ACM Digital Library,
- (3) IHS: IHS International Standards and Specifications*
- (5) ANSI,
- (6) Google.

The search has been limited to years between 2000 and 2010.

Several combinations of the search string including terms related to regulations and standards, traceability and compliance.

*http://library.dialog.com/bluesheets/html/bl0092.html

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Searching databases the search string

SEARCH STRING	TITLES	ABSTRACTS	FULL PAPERS
"standards" AND "legal requirements"	35	2	1
"standards " AND "meta models"	50	1	0
"traceability" AND ("regulations" OR "codes" OR "standards") AND "requirements"	50	4	1 ,
("standards" OR "codes" OR "regulations") AND "legal requirements"	50	5	3,
"standards" AND "customer requirements" AND "compliance"	7	1	0
"meta-model" AND "compliance"	50	2	1,

[1] By standards we mean here not only technical standards.

Searching databases the search string

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"standards" AND "customer requirements" AND "compliance"	7	1	0
"meta-model" AND "compliance"	50	2	1,

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Searching databases the search string

RESULT !!!
28 papers considered as relevant

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"meta-model" AND "compliance"	50	2	1

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Reading titles and abstracts of selected proceedings of selected conference and journals

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1. From the requirements engineering domain

Proceedings /Journal	Titles	Abstracts	Full Papers
RE Conference	835	6	5, [12], [104], [15], [17] ,[60]
REFSQ	259	6	1 [38]
RE Journal	299	11	3 [2], [37], [59]
ReLAW workshop	24	4	4, [58], [71], [72], [49]

2. From the software engineering domain:

C O N F E F E R E N C E JOURNAL TITLE	# TITLES	# ABSTRACTS	# FULL PAPERS
ICSE [82]	1498	11	1 [22]
ICMLA [89]	564	2	0
ICAIL [90]	437	21	8, [3], [67], [70], [9], [75], [69], [8], [77]
ICGSE [83]	165	0	0
MSR at ICSE [91]	131	0	0
SEHC at ICSE [86]	27	2	1 [105]
WCECS [87]	1431	2	0
TEFSE at ICSE [84]	33	1	0
SESS at ICSE [85]	45	3	2 [52], [53]
ICMLC [88]	72	2	0
TSE Journal [99]	5945	8	0
ESEJ Journal [93]	559	3	0
IST Journal [96]	3587	3	0
SQJ [95]	310	1	0
SEJ [107]	304	3	0
CSER [106]	431	3	1 [6]

Reading titles and abstracts of selected proceedings of selected conference and journals

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Systems engineering domain analyzed for :

- INCOSE Symposium on Systems Engineering
- Systems Engineering journal
- Conference on Systems Engineering Research (CSER)

Reading titles and abstracts of selected proceedings of selected conference and journals

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Systems engineering domain analyzed for :

- INCOSE Symposium on Systems Engineering
- Systems Engineering journal
- Conference on Systems Engineering Research (CSER)

RESULT → 3 PAPERS CONSIDERED AS RELEVANT

Using experts' knowledge and experience to search relevant papers

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- We used practical knowledge and the contact network of the second author, who is an experienced practitioner in the requirements engineering and system engineering fields
- also asked two other independent professionals (one in Software Engineering and one in Civil and Environmental Engineering)

THE RESULT → 10 PAPERS ADDED TO THE ANALYSIS SET

To compare searching of databases resulted in 9 papers, reading titles and abstracts in 28 papers

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Results summary

- We have presented the results of the survey using visualization and methodology of a systematic map approach
- we have used three categories, namely:
  - ***contribution facet*** - the possible values for this category are: (1) metric, (2) tool, (3) model, (4) method or (5) process
  - ***research facet*** - the possible values for this category are : (1) evaluation research, (2) validation research, (3) solution proposal, (4) philosophical paper, (5) experience report and (6) opinion paper
  - ***topic facet -*** the possible values for this category are: (1) regulatory codes creating, (2) regulatory codes tracing, (3) regulatory codes searching and analyzing, (4) law creating, (5) law tracing and (6) law searching and analysis

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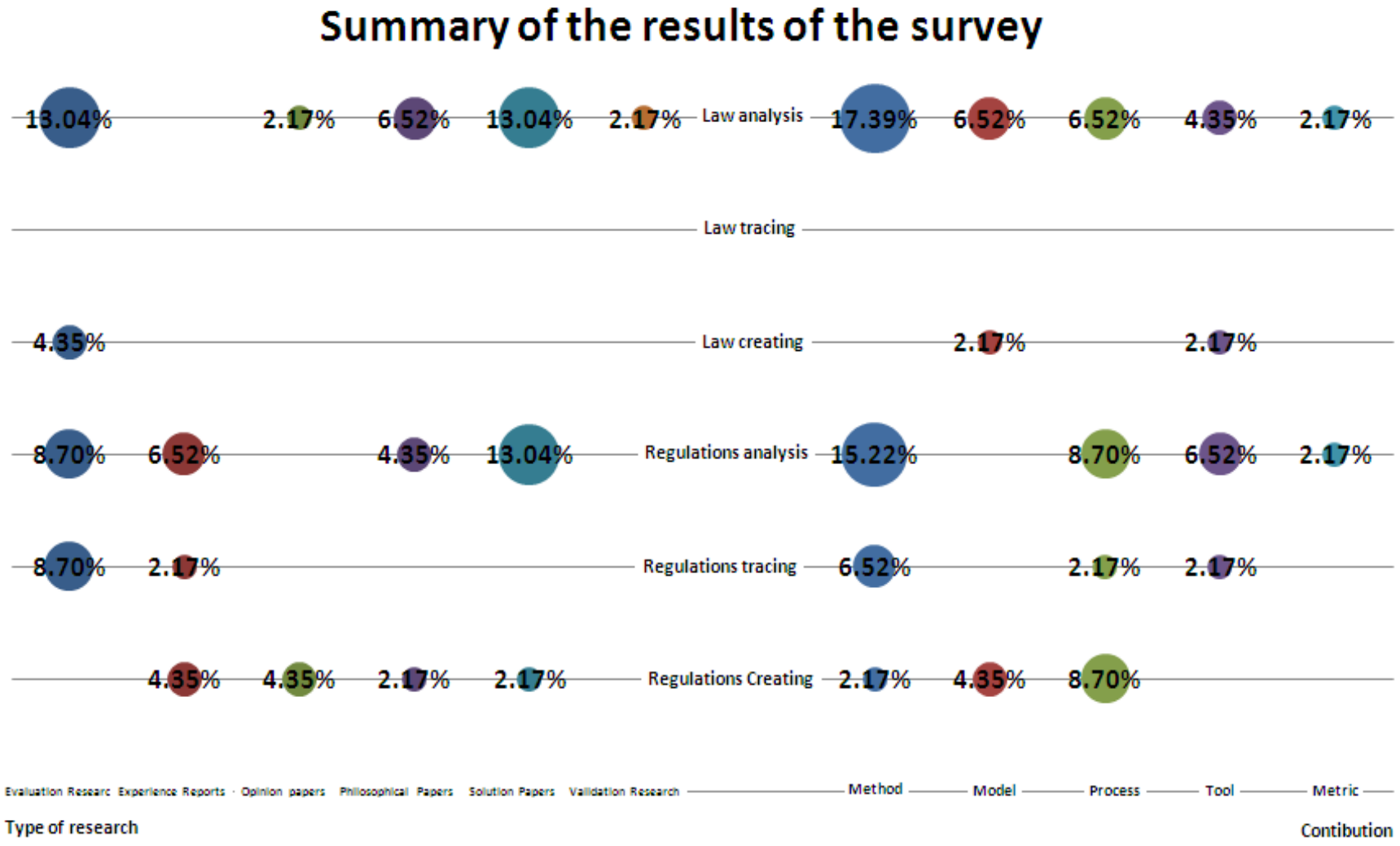
RESULTS – VISUALIZATION



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Challenges and new research areas

- Six papers were categorized in the *creating regulations category*
- Two of them were opinion papers
  - Lane[1] concludes that companies should stop creating different standard and start collaboration on common global standards
  - Best[2] describes the similarities and differences between various standard organizations
- Two papers categorized as experience reports
  - Updegrove[3] describes the raise of a new type of organization to address the situation of providing a set of tightly coordinated standards for many different standards organizations.
  - Mackey[4] describes the regulatory history and environment for development of telecommunications systems in the United States

1. Lane, G. T. 2009. Best Practices for Standards Communities. *Computer 42(7): 86-87.*
2. 2. Best, K.F. 2007. Convergence and harmonization of standards organizations. In proceedings of the 5th Int. Conference on Standardization and Innovation in Information Technology. Calgary. pp.105-112,
3. Updegrove, A. 2005. The Rise of the Meta-standard Consortium. *Consortium Standards Bulletin 4(5).*
4. Mackey, W.F. 2001. Computer Sciences Corporation The Regulatory History and Environment for Development of Telecommunications Systems in the United States, The Eleventh Annual Internation Symposium of The International Council On Systems Engineering, Melboune, Australia on July 1 - 5, 2001

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Challenges and new research areas

Six papers were categorized in the creating regulations category

- One solution proposal paper:
  - Dori et al.[1] propose a combined, model-based structured graphical and textual meta-standard approach for specification, verification and validation of complex systems in general and ISO enterprise standards in particular
- One philosophical paper:
  - Fenves et al.[2] stress the need for research that addresses the inadequacies of the current representation of standards and creates models that are able to represent all, or almost all, of the different types of provisions in any given standard.

1. Dori, D, R. Martin, and A. Blekhman. 2010. Model-based meta-standardization. Proceedings of the 4th Annual IEEE Systems Conference. pp.593-597, 5-8 April 2010
2. Fenves, S. J, J. H. Garrett, H. Kiliccote, K. H. Law, K. A. Reed. 1995. Computer Representations of Design Standards and Building Codes: U.S. Perspective, *International Journal of Construction Information Technology 3(1): 13-34.*

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Conclusions

- Our study revealed lack of publications in supporting the process of creating regulatory codes
- Moreover, only two publications were categorized to the *law creating* category
  - Bench-Capon[1] presents a study from 1987 that is addressing the provision of knowledge based decision support to large legislation based organization.
  - Schweighofer et al.[2] present a KONTERM system where legal knowledge about concepts and documents is represented by a knowledge base which is structured by statistical and connectionist methods

1. Bench-Capon, T. J. 1987. Support for policy makers: formulating legislation with the aid of logical models. In Proceedings of the 1st international Conference on Artificial intelligence and Law (Boston, USA). pp. 181-189.
2. Schweighofer, E, W. Winiwarter, and D. Merkl. 1995. Information filtering: the computation of similarities in large corpora of legal texts. In Proceedings of the 5th Int. Conference on Artificial Intelligence and Law (College Park, Maryland, United States, May 21 - 24, 1995). ICAIL '95. ACM, New York, NY, 119-126.

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Unclear if both methods may not work for regulatory codes !!!

1. Bench-Capon, T. J. 1987. Support for policy makers: formulating legislation with the aid of logical models. In Proceedings of the 1st international Conference on Artificial intelligence and Law (Boston, USA). pp. 181-189.
2. Schweighofer, E, W. Winiwarter, and D. Merkl. 1995. Information filtering: the computation of similarities in large corpora of legal texts. In Proceedings of the 5th Int. Conference on Artificial Intelligence and Law (College Park, Maryland, United States, May 21 - 24, 1995). ICAIL '95. ACM, New York, NY, 119-126.

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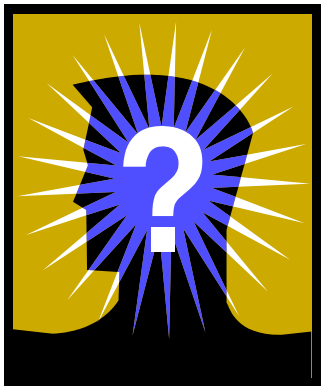

Questions?