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A systematic literature review to address overlapping laws in Indonesia

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ABSTRACT

The vast number of laws often result in legal uncertainty due to overlapping, conflicting, and inconsistent regulations. Identifying and resolving these overlaps is essential for ensuring legal clarity and coherence. This systematic literature review (SLR) explores technologies that have the potential to address the issue of overlapping laws in Indonesia. This study reviews numerous works on knowledge graphs (KGs) and graph mining, focusing on their potential to automate the detection of overlapping laws, thereby streamlining the process of legal harmonization. The review identifies several key research opportunities, such as refining KG construction, exploring semantic similarity measures, enhancing the interlinking of legal information, and ensuring explainability and interpretability. These opportunities promise to enhance the efficiency and effectiveness of detecting overlapping laws and contribute to a more consistent legal system in Indonesia.

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1. INTRODUCTION

Legal document analysis has become a critical research area as the volume and complexity of legal texts continue to grow worldwide. In Morocco, ontology-based methods have been employed to enhance information extraction from legal cases, achieving high precision through rule-based and statistical extraction techniques [1]. The rule-based mechanism in their system has achieved an impressive F1-score of 99.5%, demonstrating its efficiency in extracting critical legal entities. In Indonesia, where court decisions generate vast amounts of legal data, transformer-based models such as cross-lingual language model-robustly optimized BERT approach (XLM-RoBERTa) have been applied to perform legal entity recognition (LER) with F1-scores reaching 0.9295 [2]. These developments highlight the global progress in legal document processing, making legal data more accessible and actionable for practitioners and the public alike.

In Indonesia, there are so many laws (in Indonesian: *undang-undang*), government regulation (*peraturan pemerintah*), and ministerial regulation (*peraturan menteri*) that it cause overlapping [3]–[7]. Indonesia's President Joko Widodo has chosen the omnibus law as a way to simplify and address the complex laws and regulations [8]. The term "omnibus" used in Latin America to denote laws that streamline multiple regulations [8]. The omnibus law consolidates 177 different Indonesia's laws into a single law aimed at job creation and addressing conflicts between central and regional regulations [9]. Its primary goal is to boost foreign investment and stimulate economic growth [10].

In United States, a study aimed to address conflicts in regulations where one provision might be more restrictive or directly conflict with another [11]. The researchers developed a regulatory document mining system using a tree representation of knowledge, converting regulations into extensible markup language (XML), applying feature extraction and term frequency/inverse document frequency (TF/IDF) normalization, and calculating similarity scores. However, this study, conducted over 20 years ago, was specific to U.S. law, which differs significantly from Indonesian law, highlighting the need for research tailored to Indonesia. A study in Indonesia focused on identifying regulations with the same theme to avoid conflicts or overlaps [12]. The researchers proposed a solution using a TF/IDF and cosine similarity for query matching. They also classified regulations based on their originating unit, achieving 82% accuracy with Naive Bayes through a 10-fold test. However, this approach requires a specific query, which is a limitation when searching for overlapping laws where the query may not be known, making mining hidden information techniques more suitable.

There is no clear solution principle that can be applied to every case of overlapping laws, as every case has a unique solution [13]. This indicates that further research is still needed to find effective solutions to address the overlapping laws problem. It is important to start by finding and recognizing these overlapping laws in a large set of legal documents. This recognition process is a crucial first step in addressing the issue and will make it easier to develop effective plans for handling and reducing the impact of overlapping laws. When these overlapping laws are accurately detected, policymakers and legal experts then can create specific solutions and actions to guarantee clear and consistent laws in the legal system, such as establishing an omnibus law.

While [14] reviewed legal ontologies only, this study will specifically targets knowledge graphs (KGs) and graph mining potential applications for legal documents. KGs have been used as the foundation for systems like a virtual assistant (VA) for Indonesian laws, where they successfully integrate KG and information retrieval methodologies to handle typical legal inquiries [15]. On the other hand, graph mining also holds potential for the legal domain, with applications already demonstrated in fields like realty [16], drug discovery [17], and government data [18]. Despite growing interest in KGs and graph mining technologies across various fields [16], [18]–[32], there is a significant gap in systematic reviews focused for the legal domain. This study fills that gap.

By conducting a systematic literature review (SLR), the benefits and limitations of a specific topic could be summarized, gaps in current research can be identified, and a background can be provided to position new research activities [33]. This study is structured as follows. Section 2 contains the details of the use of Kitchenham's method for conducting this SLR. Section 3 contains the reports from conducting the SLR, including the answers to the research questions (RQs), and suggestions for future research opportunities. Section 4 presents the conclusions of this SLR.

2. METHOD

The Kitchenham's guidelines [33] are used for this SLR because they are more suitable for software engineering research compared to other guidelines (such as [34], [35]). By following Kitchenham's guidelines, this study ensures a structured approach to reviewing existing literature, tailored to the specific needs and complexities of software engineering research. Figure 1 shows the stages to conduct an SLR. The detailed process of each stage is explained in the subsection.

2.1. Planning stages

2.1.1. Identification of the need for a review

As outlined in the introduction (section 1), the need for a SLR in this study stems from the necessity to comprehensively summarize existing research on the potential application of KGs and graph mining in the legal domain. This review aims to provide a thorough and unbiased synthesis of current literature, allowing for the identification of gaps and opportunities for future research. By conducting an SLR, this study seeks to draw broader conclusions than those possible from individual studies, establishing a solid foundation for subsequent research activities in this field.

2.1.2. Specifying the research questions

In conducting a SLR, it is crucial to formulate RQs that are both meaningful to practitioners and valuable to researchers. In this study, the RQs were designed to explore the potential implementation of resource description framework (RDF) KGs and graph mining in the legal domain, focusing on both current applications and future opportunities. Two RQs were used as the basis for the SLR as shown in Table 1.

These questions are intended to guide the review process, ensuring that the findings are relevant to ongoing practices in the legal domain while also identifying areas where further research is needed. RQ1 focused on reviewing the problems that occurred in legal domains and how RDF and/or graph mining

implementation is used to handle these problems. RQ2 was used to analyze the prospect of using RDF and/or graph mining for research in the future based on the results of RQ1.

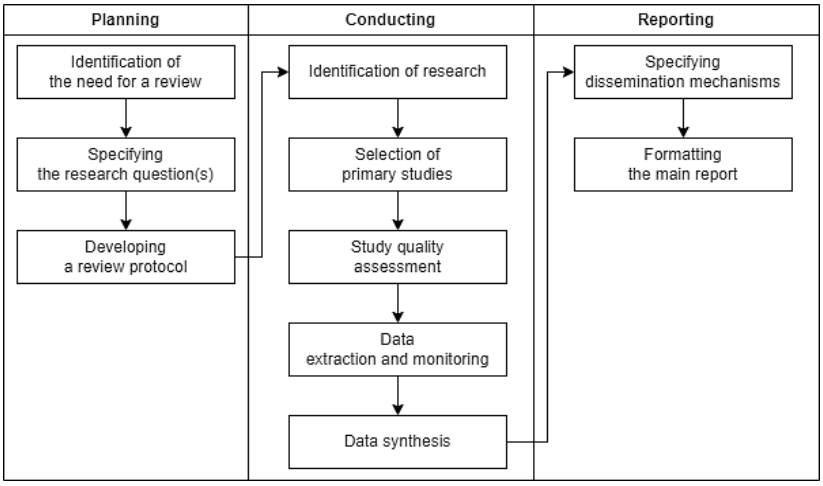

Figure 1. The stages in a SLR [33]

Table 1. RQs

RQs	Statements
RQ1	How are RDF KG and/or graph mining implemented in several legal domain problems?
RQ2	What are the challenges and opportunities of implementing RDF KG and/or graph mining in legal domain?

2.1.3. Developing a review protocol

A review protocol defines the methods for the review process, minimizing researcher bias and ensuring objectivity and reliability. This study's protocol covers search strategy, study selection criteria, quality assessment, and data extraction, detailed in subsections 2.2.1-2.2.4. Following a structured protocol ensures a thorough, unbiased, and methodologically sound systematic review.

2.2. Conducting phase

2.2.1. Identification of research

The search process is done automatically and manually. A manual search was carried out through the Association for Computing Machinery (ACM), IEEE, and Scopus digital libraries to find articles that related to RQs. A manual search is followed by an automatic search using the search string. The search string is determined by looking at the results of a manual search (based on the terms that often appear). Table 2 shows the specific query that is used on the automatic search. The manual search obtained 3 articles. The automatic search obtained 98 articles. Therefore, the total obtained article from both search processes is 101 articles.

Table 2. Query for automatic search

Source	Query
ACM	[[Full Text: "law"] OR [Full Text: "legal"] OR [Full Text: "statute"]] AND [Full Text: "documents"] AND [Full Text: "rdf"] AND [[Full Text: "graph"] OR [Full Text: "graph mining"] OR [Full Text: "mining"]] AND [E-Publication Date: (01/01/2017 TO 12/31/2022)].
IEEE	("All Metadata":“law” OR "All Metadata":“legal” OR "All Metadata":"statute") AND ("All Metadata":"documents") AND ("All Metadata":"rdf") AND ("All Metadata":"graph" OR "All Metadata":"graph mining" OR "All Metadata":"mining").
Scopus	(TITLE-ABS-KEY (("law" OR "legal" OR "statute")) AND TITLE-ABS-KEY (("documents")) AND TITLE-ABS-KEY (("RDF")) AND TITLE-ABS-KEY (("graph" OR "graph mining" OR "mining"))) AND PUBYEAR > 2016 AND PUBYEAR < 2023 AND (LIMIT-TO (SRCTYPE , "p") OR LIMIT-TO (SRCTYPE , "j")).

2.2.2. Selection of primary studies

The articles obtained from the search process were selected through two phases. Initially, titles, abstracts, and keywords were reviewed. Articles that passed the first phase were then evaluated by reading the

full text. Decisions at both phases were based on the inclusion/exclusion criteria in Table 3. In the first phase, 5 out of 101 articles from the search process were not selected based on manually reading the title, abstract, and keyword. The result from the first phase is 96 articles. In the second phase of the selection process, the full text of those articles was skimmed, and the results were 21 articles selected.

Table 3. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Article written in English.	Article not primary studies.
2. Article published between 2017 and 2022.	Article not related to the RQ.
3. Article published in journals or conferences.	
4. Article related to RQs.	

2.2.3. Study quality assessment

In the study quality assessment of this SLR, each article will be scored according to these criteria, with three possible ratings: "Well" (scoring 1 point), "Reasonably" (scoring 0.5 points), and "Poorly" (scoring 0 points). The total score for each article will be calculated, with a maximum possible score of 3. To pass the quality assessment, an article must achieve a minimum score of 2. Notably, all the selected articles from the previous step either met or exceeded the cutoff score, except for 5 articles that failed this stage due to being insufficiently related to the RQ. The evaluation of each selected article's quality will be based on three key questions:

- How well is the paper aligned with the RQ?
- How well was the approach to, and formulation of, the analysis conveyed?
- How clear and coherent were the links between data, analysis, and conclusions?

2.2.4. Data extraction and monitoring

After ensuring quality, the next step is data extraction. The following data were extracted from the selected article in the parsif.al website: search mechanism (automatic or manual), source (journal name, database name and article title, respectively), title, keywords, authors, type (journal or proceedings), year, data collected, objective, summary of the study, and quality assessments score. The extracted data would be synthesised and made into charts. Figure 2 compares the number of retrieved and selected articles between 2017 and 2022. This figure demonstrates that although many articles were retrieved each year, only a few were selected, particularly in more recent years.

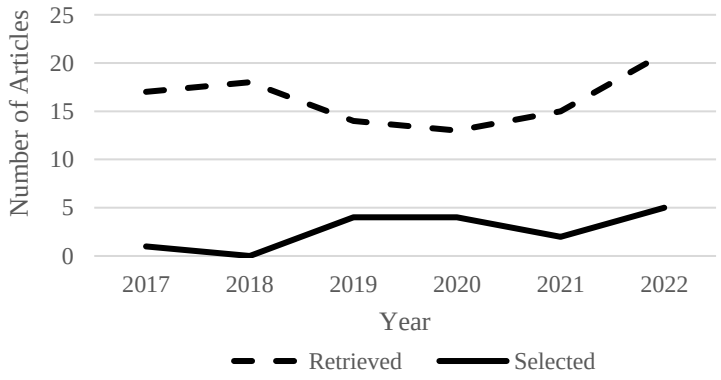

Figure 2. Article distribution by year of publication

2.2.5. Data synthesis

In the data synthesis step, each selected article will be carefully summarized, with key findings, methodologies, and outcomes highlighted. Additionally, research opportunities emerging from the reviewed studies will be identified. This approach aims to not only provide a clear picture of the current landscape in the field but also propose potential avenues for future research. While the synthesis will be non-quantitative, it will offer a detailed and structured analysis that supports the review's objectives and contributes valuable insights.

2.3. Reporting

2.3.1. Specifying dissemination mechanisms

In this step, the focus is on determining the most effective ways to disseminate the findings. The highest priority is given to publishing in a reputable international journal. This ensures that the review reaches not only a wide range but also relevant academic and professional communities.

2.3.2. Formatting the main report

In formatting the main report of this SLR, particular emphasis will be placed on presenting a clear analysis of the findings in section 3. It is also a crucial step to ensure that the review meets the standards and guidelines of the target journal. Careful attention will be paid to clarity and conciseness, ensuring that the report is not only informative but also easy to navigate for reviewers and readers.

3. RESULTS AND DISCUSSION

3.1. Results reporting on RQ1

The selected articles have explored various implementations of RDF KGs and graph mining. However, there is no one to review how these articles can solve their problems, leaving gaps in understanding their potential in legal domains. This study identifies several domains that could be explored using RDF KGs and graph mining, as mapped in Table 4. Subsubection 3.1.1 until 3.1.3 show the details of our findings highlight similarities and differences across these studies.

Table 4. Mapping of problem domains

Domain	Amount	Article
KGs construction	6	[36]–[41]
Integration of KGs	3	[42]–[44]
Application and analysis of KGs	7	[45]–[51]

3.1.1. Knowledge graphs construction

RDF KGs are used as the target format for converting unstructured or semi-structured legal documents into structured, machine-readable formats. For example, c employs a pipeline of entity extraction, relation extraction, and triple construction based on Nyaya Ontology to transform Indian Supreme Court judgments into RDF. Similarly, Abdurahman *et al.* [40] outlines a process for converting Indonesian legal documents in PDF format to RDF, capturing metadata, document structures, textual content, and inter-document relationships like amendments and citations. According to Junior *et al*. [41], mapping languages are employed to automate the transformation of XML-based legal documents into RDF, making legal semantics explicit. Martín-Chozas [39] highlights a methodology for extracting and enriching terminologies from legal documents, using RDF and linked data principles on diverse legal corpora. Sinif and Bounabat [36] discusses a framework for generating RDF representations of heterogeneous datasets, focusing on improving data quality and linking through NLP. Lastly, Stavropoulou *et al.* [37] utilizes RDF and semantic annotations to create a multilingual legal KG for European Union (EU) legislation, providing advanced data analytics, visualization, and querying capabilities.

The papers share common goals; thus, all aim to convert unstructured or semi-structured legal data into structured formats like RDF. Techniques such as entity extraction, relation extraction, and semantic modeling are central to some frameworks, with a focus on domain-specific applications (e.g., legal or government). The approaches diverge based on their scope and application focus. While some papers like [38], [40] focus on national data (Indonesia and India, respectively), others like [37] target international frameworks like the EU. Sinif and Bounabat [36] focuses public transparency, while Martín-Chozas [39] highlights integration with external resources.

3.1.2. Integration of knowledge graphs

RDF KGs play roles in the integration of legal KGs. RDF triples and ontologies such as European legislation identifier (ELI) and European case law identifier (ECLI) are employed to connect national and international legal documents, facilitating machine-readable frameworks for querying cross-border legal information [43]. Similarly, Loutsaris *et al.* [42] integrate ontologies like Akoma Ntoso and ELI to transform unstructured legal texts into structured RDF triples using text mining techniques, bridging gaps between multiple national databases and systems. Beris *et al.* [44] utilizes RDF to interlink government decisions with

external datasets, incorporating blockchain technology to ensure the immutability and trustworthiness of public sector records.

Each work highlights the necessity of connecting fragmented legal systems into a unified framework to facilitate data exchange. Despite the shared themes, Filtz *et al.* [43] focuses on European-wide integration, creating a pan-European KG. Beris *et al.* [44] emphasizes national-level integration in Greece, with a focus on Greek legislation and public sector decisions. Blockchain technology is central to the Greek case study [44], ensuring tamper-proof systems. The other two papers rely on ontologies [43] and text mining [42] for integration. Paper [42], [43] focus on information accessibility, while the Greek public-sector paper [44] aiming to rebuild trust and transparency through technologies. These systems demonstrate how RDF enables integration across diverse legal datasets, making legal information accessible.

3.1.3. Application and analysis of knowledge graphs

Several papers highlight the use of RDF KGs to enhance the retrieval and querying of legal information. For instance, Promikyridis and Tambouris [51] demonstrates the application of RDF for core public service vocabulary (CPSV) to manage and query it, improving the accessibility of public service descriptions. Research by Erekhinskaya *et al.* [49] demonstrates how RDF and ontologies enhance NLP tasks like information and relation extraction, output validation, semantic search, and question answering. The use of RDF KGs also supports the development of intelligent systems such as question-answering frameworks and VA. For example, Wang *et al.* [48] constructs a KG to represent discipline inspection laws, employing semantic matching with TF-IDF models to answer questions efficiently. Similarly, Faisal *et al.* [50] employs RDF to encode labor-related laws, enabling conversational AI systems to retrieve and present legal information interactively (and can therefore be considered a VA). Jouis *et al.* [46] proposes embodied carbon in construction calculator (EC3) software based on applicative and cognitive grammar (ACG) to process legal texts into semantic representations, which could be visualize into graph.

Mining techniques are also employed to process and analyze legal KGs. Research by Kwashie *et al.* [45] utilizes graph differential dependencies (GDDs) to perform entity resolution, which is potential to legal domain (linking entities for law enforcement purpose). In another paper, Weichselbraun and Kuntschik [47] highlights conciseness issues in linked enterprise datasets, such as the need to disambiguate multiple legal entities for organizations. The paper [47] also explores other data quality challenges in linked data and propose graph mining-based strategies for data enrichment, enabling semantic search and browsing.

3.2. Results reporting on RQ2

The application of RDF KGs in the legal domain is a growing field. Existing research, Abdurahman *et al.* [40] successfully converted 784 Indonesian laws into an RDF KG, facilitating queries, chatbot, and visualization. Similarly, Faisal *et al.* [50] implemented a legal VA using KGs for Indonesian Labor Law, enhancing legal information access. Yet, the research remains limited in detecting overlapping laws, a critical issue in ensuring legal consistency. Future implementations of graph mining, such as [52], but specifically tailored to legal documents, could bridge this gap. Additionally, refining entity extraction techniques and improving the semantic similarity measures between legal provisions could enable more accurate conflict detection. Another promising avenue is enhancing the explainability of these systems to ensure that legal professionals can trust and understand the results generated by the VA. The legal VA created by Faisal *et al.* [50] can be used to search an answer in the form of regulations or laws based on user needs through queries based on the KG created by Abdurahman *et al.* [40]. In the query performed by Legal VA, the user already knows what law they want to search for. In the case of overlapping laws, we certainly do not know which laws overlap, so a special technique is needed.

The hypothesis of our research is that, by utilizing graph mining techniques, searching for overlapping laws in the KG can be done. Querying involves users searching for specific information they are looking for, such as the content of a specific article in a law. On the other hand, mining refers to the process of searching for implicit or hidden information when the user is not exactly sure of the desired outcome. For example, requesting to find overlapping laws. We hypothesize that the said KG built by Abdurahman *et al.* [40] could be used to detect overlapping laws by using graph mining. Based on the SLR that has been conducted, Eddamiri *et al.* [52] was eliminated in stage 2.2.3 due to its lack of relevance to the legal domain, even though its approach to graph mining presents an interesting pipeline for knowledge discovery that could be adapted for legal applications. This article demonstrates the potential of graph mining and RDF for knowledge discovery and tasks like clustering and theme identification. While it is very related to graph mining and RDF, the research in [52] is more general, and it does not specifically focus on the legal domain.

The future research plan involves developing a system that utilizes KG and graph mining techniques to detect overlapping laws. This research aims to address a problem in identifying overlaps between laws, which is crucial for ensuring legal consistency and avoiding conflicts. Therefore, the research gap lies in the specific focus and application domain. Bridging this gap would involve developing a specialized approach that

combines the strengths of RDF graph mining and graph mining techniques to address the specific problem of detecting overlapping laws in the legal domain. Eddamiri *et al*. [52] use the RDF graph mining pipeline for clustering tasks on datasets related to publications, geology, and conferences. In contrast, the future research plan aims to implement this pipeline on legal documents. Developing a system to detect overlapping laws using KG and graph mining presents several exciting research opportunities:

- KG construction: research can focus on refining the methods for constructing comprehensive and accurate KGs from legal documents.
- Entity and relation extraction: improving entity and relation extraction techniques can enhance the system's ability to identify key legal concepts and their relationships.
- Overlapping law detection: investigating novel graph mining algorithms to handle complex legal structures and identify inconsistencies and overlaps between legal provisions effectively.
- Semantic similarity: research can explore semantic similarity measures to quantify the degree of overlap between legal provisions or determining the extent to which they share common elements.
- Interlinking legal information: developing techniques for interlinking legal information across different sources can enhance the system's ability to access relevant data from diverse legal databases and enhance the accuracy of overlapping law detection.
- Explainability and interpretability: ensuring the explainability and interpretability of the system's results to present the detected overlapping laws in a transparent and understandable manner to legal professionals and end-users.

4. CONCLUSION

A SLR was conducted on RDF knowledge graph and graph mining. These technologies have been applied to various domain problems, including knowledge graph construction, integration, analysis, and application. This review also highlights opportunities for future research, laying the foundation for the next steps. The subsequent phase of this research will focus on modifying RDF graph mining pipeline to detect and identify cases of overlapping laws in Indonesia.

The findings of this study have significant implications for legal text analysis and the broader community engaged in regulatory frameworks in Indonesia. By utilizing graph mining and knowledge graph technologies, this research offers a fresh perspective on identifying conflicts in overlapping laws, an area traditionally dominated by other approaches. This shift broadens the research scope and opens new possibilities for legal analysis, providing more interpretable methods for detecting inconsistencies within regulations.

The topic of this research is vital because overlapping regulations can lead to legal confusion and diminish the effectiveness of the legal system. Our claim is that KGs, when combined with graph mining, offer a more effective approach to uncovering hidden overlaps in laws. Future research should focus on improving conflict detection and refining these methods to support legal reforms, ensuring a clearer and more efficient legal system in Indonesia.

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AUTHOR CONTRIBUTIONS STATEMENT

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Gusti Ayu Putri Saptawati	✓	✓		✓			✓			✓		✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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