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Public licenses in Software Engineering: A Multivocal Literature Review

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Tiivistelmä — Referat — Abstract

Context: Public licenses are central to the distribution of works in software engineering. For example in open source there must be an appropriate public software license attached to the source code in order for open-source software to be freely available for possible modification and redistribution. Understanding public licenses can be difficult. This could stem from the legal nature of the license texts and the large number of already-existing public licenses. As a result some actions made within the boundaries of the public licenses may come as a surprise to the public.

Objective: The primary goal of this research is to conduct a multivocal literature review of the current state of public licenses in software engineering, the evaluation of the them and the evidence level of the research. The research aims to provide a novel perspective on relevant licenses and to extract key findings through a rigorous literature review process. This study has two main viewpoints: to provide rigorous research on public licenses to the academic field and to provide insights to the professional field of software engineering on public licenses. The grand goal of this thesis is to raise awareness of the importance of public licenses so that more licensers would make the correct choices based on their situations and needs in a mindful way.

Method: The search strategy examined 656 sources, found through websites that list public licenses and ad-hoc searches. Applying inclusion and exclusion criteria resulted in the selection of 656 sources, which made relevant contributions related to public licenses in software engineering.

Results:

Conclusions:

ACM Computing Classification System (CCS)
Social and professional topics → Computing / technology policy → Intellectual property → Licensing

Avainsanat — Nyckelord — Keywords

open source, free / libre software, copyright, proprietary software, copyleft, license

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Contents

1 Introduction

Public software licenses play a central role to the distribution of works in software engineering. For example in open source there must be an appropriate public software license attached to the source code in order for the piece of software to be freely available for possible modification and redistribution. Because open source is central to software engineering the licenses enabling open source must also be considered important in the same context.

Public license is defined by Wikipedia with the following words (Wikipedians, 2024a):

> "A public license is a copyright license where the licensees are not limited. Examples include free content, open content, Creative Commons, free software and open source licences."

Understanding public software licenses can be difficult. This could stem from the legal nature of the license texts and the large number of already-existing public software licenses. The license texts usually favors correctedness over the readability for the developer. This is because the license text has to act as a valid legal instrument otherwise it cannot be endorsed (Ferguson, 2006). The lack of understanding of public software licenses leaves too much room for interpretation. In June 21, 2023 International Business Machines' (IBM) Red Hat seemingly violated the spirit of a popular public software license, the GNU General Public License version 2 (GPL-2.0) (Kuhn, 2023) (McGrath, 2023). This was an unpleasant surprise to the public. If the public software licenses would be more easily understood, the proprietarization of RHEL would have been less of a surprise to the users. To give some context on the violation of the spirit of the GPL-2.0, the project behind GNU General Public License (GPL), GNU Project initially attempted to ensure the users via the GPL have to the following three freedoms (GNU, 1996):

- Freedom 1: The freedom to study how the program works, and change it so it does your computing as you wish. Access to the source code is a precondition for this.
- Freedom2: The freedom to redistribute copies so you can help others
- Freedom 3: The freedom to distribute copies of your modified versions to others. By doing this you can give the whole community a chance to benefit from your changes.

Access to the source code is a precondition for this.

On top of the legal details of public software licenses, software engineers in general have a tough time understanding the basic goals of public licenses used in software engineering. In the instance of the RHEL incident it would have been even lesser of a surprise to software engineers if they would have known about other public software licenses and what they try to achieve, or how old is GPLv2 and why it has been succeeded by GNU General Public License version 3 (GPL-3.0).

This thesis' goal is to contribute into the solving these problems in a structured manner. First we state definitions and terminology used in the scope of this thesis. We go over the reasons why there does not exist consistent terminology in this area and conversely why the definitions are the most stabile ones in this area. Second we take a deep dive into the public software licenses through a multivocal literature review. To make more information available, a mapping study connected to the terminology scope defined in the first step is needed. Third includes our own suggestions and basic knowledge for professionals and academics in the industry to enhance the understanding of public licenses in software engineering. This step also includes discussion of the future research and contributes to stablizing the terminology and reinforcing the already-existing definitions in the academic field.

1.1 Research goal, questions and contributions

The primary goal of this research is to conduct a multivocal literature review of the current state of public licenses in software engineering, the evaluation of the them and the evidence level of the research. The research aims to provide a novel perspective on relevant licenses and to extract key findings through a rigorous literature review process. The research questions of the review are:

- RQ1: How many public software licenses are there in the top five software license listing cites?
- RQ2: How much is there disagreement in the shortcode names between different public software licenses listing sites?
- RQ3: How many public licenses in software engineering does there exist?

Terms such as open source, source code, free software and other vocabulary must be defined in the scope of this thesis. Section 1.3 will examine this plethora of of terminology and definitions and will be used to establish a sound basis for discussing this broad subject.

This study has two main viewpoints. The first one is to provide rigorous multivocal research on public software licenses to the academic field. Because this thesis already does the multivocal work on public licenses in software engineering, the researches of the future can cite the results of this thesis without having to mark their study a multivocal one. This is the grand goal of this thesis. The second one is to provide insights and general metrics to the professional field of software engineering on public software licenses. Hopefully this makes conversation on public licenses in software engineering easier and more rooted to scientific research rather than gut feeling and old, non-scientific articles on the insights and metrics of public licenses in software engineering.

1.2 Thesis structure

This thesis follows the IMRaD structure. Chapter 1 introduces the problem, this thesis' possible contributions and some further background. Chapter 2 goes over the process and the methods of the multivocal literature review. This is where most of the actual research takes place in. Chapter 3 presents results to the research questions. Chapter 4 discusses implications for research. The chapter also discusses software engineering professionals in the thesis' context and the validity of the thesis' research. Chapter 5 concludes this thesis with the help of the research questions and the future of the research.

1.3 Background and terminology of public licenses

The current terminology is used inconsistently which leads to incorrectness in the field of software engineering. For example The Open Source Initiative (OSI) classifies GPL-3.0 under the term "open source" whereas the Free Software Foundation (FSF) classifies GPL-3.0 under the term "free software" (OSI, 2008)(Stallman, 2009). Some parts of the two definitions are mutually exclusive. This is rarely mentioned when people talk about Free and Open Source Software (FOSS) or Free / Libre and Open Source Software (FLOSS) which leads to misunderstanding that the two approaches are the same. This is why our focus will be public licenses in software engineering, and not for example, FLOSS licenses in software engineering. This also distinguishes our investigation from the broader topic

of copyright licenses or the copyright law. This also includes public software licenses that are not approved by the FSF nor OSI hence not falling under the group of FLOSS licenses. In this section we aim to increase the accessibility of our discussion by providing a concise overview of the background of the field of public software licenses and the terms we employ.

Another example of term inconsistency is the term ”copyleft”,which is defined by Mustonen, 2003 in the following way:

> ”Copyleft is a novel licensing scheme. It facilitates open and decentralized software development. Its key feature is that once a program is licensed by the inventor, the subsequent programs based on the original must also be licensed similarly.”

Like with the definition of sustainability (Neumayer, 1999), copyleft also has the definitions of weak and strong within the term (Wikipedians, 2025). Weak copyleft licenses are often used to cover software libraries. This allows other software to link to the library and be redistributed without the requirement for the linking software to also be licensed under the same terms. Strong copyleft shares the same features Mustonen, 2003 presents regardless of the library nature of a piece of software. The general use of the term ”copyleft” without the prefix also leads to inconsistency in the term usage.

To explain our emphasis on public licenses in software engineering, it is essential to examine the other possible areas of interest in public licenses. Our study classifies such efforts into eight domains as mentioned by the GNU Project (GNU, 2023). These domains include:

- public licenses in software engineering
- public licenses in documentation for example architecture documentation of a project that may or may not be software or even publicly licensed
- public licenses in artistic works for example digital art, music or videos
- public licenses in educational works
- public licenses in fonts
- public licenses in viewpoints
- public licenses in physical objects
- public licenses in other works

The primary aim of this study is to investigate public licenses in software engineering process. However, it is important to acknowledge that public licenses in software engineering is only one aspect of public licenses in general. These additional dimensions are crucial in adoption and implementation of public licenses in software engineering, but they are not the focus of this thesis.

For example, including artistic works such as music would require us to understand the basics of music theory and what sets apart distinct pieces of music from one another, something that could be outside the skillset of the author. While developing a comprehensive theory, framework, and tooling for public licenses as a whole is a gargantuan task beyond the scope of a single thesis, narrowing our focus to software engineering enables us to examine a more concise and complete aspect of the main topic of this thesis.

As significant point of clarification, it is essential to acknowledge that public licenses are generally meant to be used as valid legal instruments. The question whether or not a public license can act as a legal instrument is critical to the main function of these licenses. However, this thesis will not focus on the legal doctrine aspects either. The enforceability of public licenses has seen discussion in the academic field of law since the dawn of these licenses and since there's already an academic base for research it is likely the discussion seems to continue on with a healthy amount of activity (Duisburg, 2011).

Since the most recognized public licenses in software engineering are either open-source licenses or free software licenses and since both paradigms are driven by different organizations with different goals and values, it is understandable how non-standardized the terminology in the scope of public licenses in software engineering is. The example given in the first section of this sub-chapter illustrates the challenges involved in maintaining consistency in the use of terminology in this emerging field and further warrants a closer inspection of the terminology to emphasize our own standing in the field.

To provide an understanding of the terminology used in the first paragraph of this section, a Venn diagram is presented in Figure 1.1, which contextualizes the non-standardized terminology within the public software license scope as a whole. This perspective provides an increased understanding of where different subdomains fall in the larger picture of public software licenses. Furthermore it is essential to note that public licenses in software engineering encompasses different aspects that require a closer examination.

Let us explore further the differences and similarities between open source and free software at the software engineering level of public licenses. This is a crucial step since we can see from the approximation in Figure 1.1 that the majority of public software licenses are

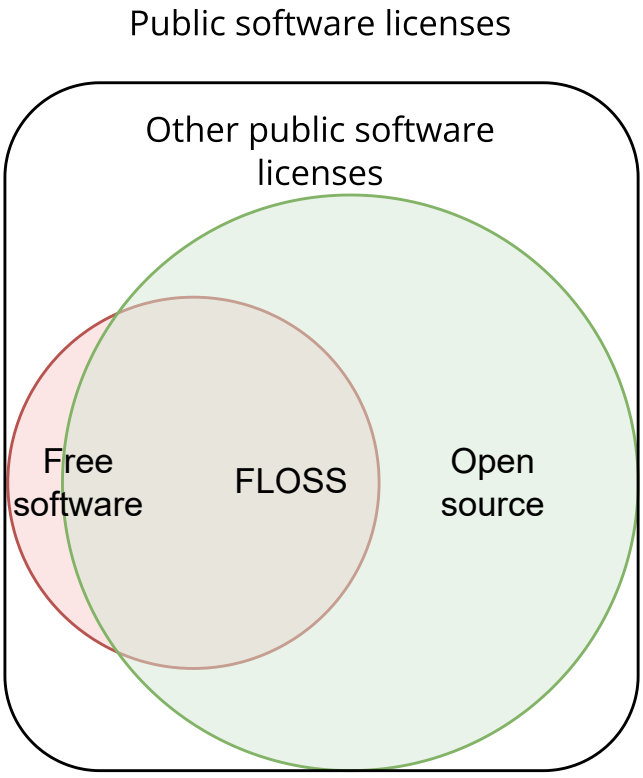

Figure 1.1: Public licenses in software engineering

either open source, free software or both. We glanced over the free software definition in the first section of Chapter 1. Open Source Initiative defines open-source licenses in the Open Source Definition briefly in the following way (OSI, 2024):

> ”Open source licenses are licenses that comply with the Open Source Definition - in brief, they allow software to be freely used, modified, and shared.”

Like the FSF with free software, OSI has the final word on what passes as open source and what does not. For example a new public software license will not classify as free software nor open source until the corresponding organization has acknowledged the public software license as either free software, open source or neither. If a public software license is accepted by both FSF and OSI it will fall under the term FLOSS. If a public software license gets accepted by neither of the organization or it gets rejected by both organizations it will fall under ”Other public software licenses” in the Figure 1.1. In general the strong copyleft free software license requirements are considered more strict than the open source license requirements. For the sake of perspective we could simplify the differences like so: free software requires the redistributions of the licensed software to be open as well but open source licenses do not usually require this. The terms free software and open source

are in general often misunderstood or just thought of as FLOSS collectively because the terms have a hard time conveying their paradigms in the natural language. One would not think free software does not mean software free of charge nor would one think that open source allows closed source redistributions of the licensed software. We will glance over the impacts on the industry of these two terms in Chapter 4.

With the context laid out in this chapter let us define public licenses in software engineering for the purpose of this study: Public software licenses are copyright licenses where the licensees are not limited and the copyright license in question is meant be used in licensing software source code. This helps us create the search strings and find the relevant literature for this thesis. This also helps us exclude public licenses regarding documentation, media and all other non-software targeted public licenses.

The quest to categorize every public software license under some paradigm objectively is a complex one and cannot be comprehensively answered in a single paragraph. Therefore it is essential to continue taking the correct steps towards incresing the scientific understanding and providing the industry with examples, standards and processes to follow. However, as the following chapters reveal, a significant amount of effort is still being spent on solving the same problem multiple times, rather than building on existing knowledge and finding the next problem to solve. This thesis aims to contribute to mitigating this challenge by providing a rigorous analysis of the current state of the field. As the knowledge, conventions, and terminology take shape,we can look forward to reaching a state where less effort is spent on defining concepts and more on practical problem-solving.

2 Methods

This chapter aims to establish a precisely defined and rigorous research approach to enhance transparency and repeatability. We will take the steps required to ensure that every phase and decision is thoroughly documented, enabling the reader to retrace the research process. In a thesis made by a single researcher, the lack of cross-examination of results with multiple researchers and the validation of evaluation criteria for opinion bias pose threats to validity, as will be clarified further in Chapter 4. Therefore, special attention will be paid to address these concerns. By following this approach, this research endeavors to contribute to the existing body of knowledge in the field of computer science in a robust and reliable manner.

The systematic literature review method is a well-established approach for conducting a comprehensive and rigorous analysis of the existing research on specific research question or subject (Kitchenham and Charters, 2007). This paper presents a multivocal literature review. Multivocal literature review is type of systematic literature review that includes both academic literature and grey literature (Garousi et al., 2019). This method was selected for this study to facilitate a thorough and scientifically interdisciplinary examination of public licenses in software engineering. The existing literature consists of public software licenses not found in academic databases and as such are considered gray literature, making the thesis a multivocal literature review.

This study follows the guidelines outlined by Kitchenham and Charters, 2007, to ensure its quality. The multivocal review method consists of three distinct phases: planning, conducting and reporting the review. This study stricly adhered to this structure. The phases can be further broken down into a research protocol, as illustrated in Figure 2.1. Adhering to the protocol is the first step in ensuring a well-documented and rigorous process, which increases the validity and auditability of the study.

The multivocal literature review process began with the formulation of research questions and the establishment of a comprehensive search strategy and scope. The search process was conducted by employing a quasi-gold standard (QGS) approach based on the implementation by Zhang and Ali Babar, 2010. After the completion of the search process, the inclusion and exclusion criteria were defined. To ensure a structured evaluation of the literature, a data extraction form was created. Finally, a strategy for analyzing the

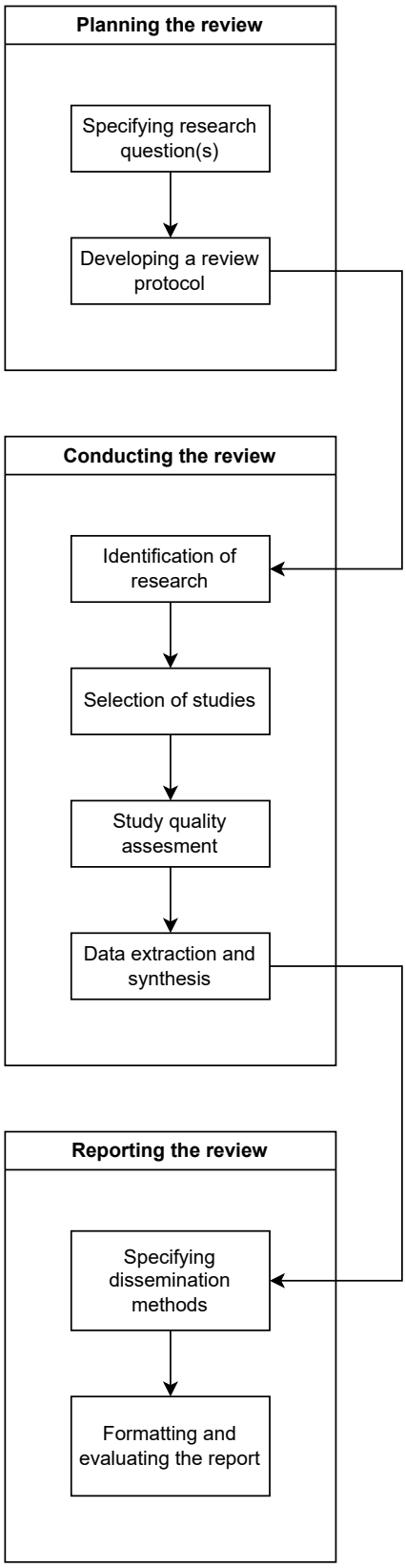

Figure 2.1: Three phases of a systematic literature review

extracted data from the literature was designed.

To ensure the reliability and validity of the research protocol, it was validated against similar systematic literature reviews in computer science, the aforementioned guidelines by Kitchenham and Charters, 2007, and was further refined through an iterative process. Specifically, a subset of the data was tested on (The QGS) and any identified issues or problems were recorded and addressed. The details of this process are explained and thoroughly documented in the following sections. Similarly, the same approach was followed for the data extraction process, whereby a subset of literature was tested to refine the data extraction form. The revision of the form was undertaken as necessary to guarantee the completeness and accuracy of the extracted data.

2.1 Research questions

The research questions in this study served two primary purposes. Firstly, they aimed to provide an analysis of the existing multivocal literature on public licenses in software engineering for the researchers interested about the field. Secondly, the questions were designed to cater a secondary audience of professional software engineering practicioners. As discussed in the Chapter 1, the following research questions were addressed in this thesis:

- RQ1: How many public software licenses are there in the top five software license listing cites?
- RQ2: How much is there disagreement in the shortcode names between different public software licenses listing sites?
- RQ3: How many public licenses in software engineering does there exist?

The multivocal literature review in this thesis begins with addressing RQ1, which aims to provide the amount of public software licenses that exist in our five public license listing sites in total. This information could be most valuable to the researchers. The results can be used to introduce some notable background of the current public licenses in software engineering and enabling focus to more specific areas inside the topic of this thesis.

Next RQ2 seeks to find the amount of duplicate licenses between the license listing sites. Results to this research question are also mostly useful to researchers of the field. Moreover, the documented methods are most likely the most valuable information for the researchers.

Finally RQ3 attempts to count the total number of individual public software licenses within the scope of this thesis. The research question builds on top of the results and methods of the previous research questions. This information could be most valuable for the practitioners since it could give some overview and a sense of the scale when picking a public software license that would serve the practitioners' needs the best.

2.2 Search stragey

The search process was conducted on five public license listing websites. The selection criteria for the literature were defined after the search process and the selection process was based on inclusion and exclusion criteria. The inclusion and exclusion criteria and each step of exclusion on the literature found are presented later in this chapter. Originally the search terms would have been applied to the license listing sites directly just like in a normal multivocal literature review or in a systematic literature review. Keywords however produced highly varying and non-reproducible results in Google Scholar and Google Search. Some license listing websites such as FSF's list of pages categorized as licenses could not be found from Google Search even with the `site` operator: `site:https://directory.fsf.org/wiki/Category:License`. Although the page has been up since 2013, for some reason Google has not crawled the page in 10 years (FSF, 2024). This is why this thesis does not include search terms of the initial phase per se but rather inclusion and exclusion strings on the second phase. For the sake of validity the thesis still follows the guidelines presented in Kitchenham and Charters, 2007 with the exception of replacing an academic database search engine with the five license listing sites, web scraping and our own Python script performing the legwork of an academic database search engine in a systematic literature review.

The data extraction process was performed in a standardized and systematic manner, with the aim of obtaining the relevant information from the selected literature. The data extraction form used included license shortcode used in the listing site, listing site name, full license text and is available Table 2.2. The extracted data was then used to answer the research questions and perform the data analysis. The results of the data analysis were then reported in a rigorous manner.

2.2.1 Search method

The search was conducted on five license listing websites, as mentioned earlier, to obtain a broad set of multivocal literature. This approach yielded a large number of literature that were processed to a subset of high-relevance literature using inclusion and exclusion criteria presented later in this chapter. Manual searching of databases with hundreds of public licenses is not feasible, and it is prone to researcher bias and may overlook relevant venues from other scientific disciplines. However, a preliminary manual search was performed to reduce the number of iterations required and establish the quasi-gold standard (QGS) mentioned earlier.

2.2.2 Search scope and terms

The search terms, or in our case, the inclusion and exclusion string was determined through an iterative process that took into account the research questions and topic. Synonyms for key terms were included and combined using Boolean logic to form a comprehensive inclusion and exclusion string. As mentioned earlier the inclusion and exclusion criteria are presented later in this chapter.

The inclusion and exclusion string was established on a basis of quasi-gold standard as proposed by Zhang and Ali Babar, 2010. For establishing a quasi-gold standard we employed a manually crafted inclusion and exclusion string based on the topic and research questions of this study. As we defined public licenses in software engineering as licenses where the licensees are not limited and the license in question is meant be used in licensing software source code in Chapter 1 and our research questions focus on finding useful metrics about the public licenses, we manually formulated the inclusion and exclusion string in Python:

```
^(?!.*\b(documentation\s+license|creative\s+commons|open data)\b).*
```

In order to run the inclusion and exclusion string that established the quality-gold standard against the literature we had to gather them first. We started defining our search scope from the Wikipedia page of one of the most used open source license (Balter, 2015), the MIT license (Wikipedians, 2024b). The infobox contained fields in the order shown in Table 2.1.

The validity threats regarding this choice are discussed in a later chapter. The publisher, GPL compatibility, copyleft and the linking exception did not result in any meaningful

Field	Value
Publisher	Massachusetts Insitute of Technology
SPDX identifier	MIT
Debian FSG compatible	Yes
FSF approved	Yes
OSI approved	Yes
GPL compatible	Yes
Copyleft	No
Linking from code with a different license	Yes

Table 2.1: MIT License Wikipedia page infobox

URL
https://spdx.org/licenses/
https://wiki.debian.org/DFSGLicenses
https://directory.fsf.org/wiki?title=Category:License
https://opensource.org/licenses
https://www.gnu.org/licenses/license-list.html

Table 2.2: License listing sites chosen

license listing websites. This leaves us with the SPDX, Debian FSG compatibility, FSF and OSI from which all resulted in some sort of license listing websites. Since the fields were roughly as follows: SPDX, FSF, OSI and GNU, after some investigating, we decided to start the search for public software licenses from the following license listing sites:

The web pages were scraped of the public license shortcodes using the browser's developer tools. These shortcodes were imported into a spreadsheet editor with each shortcode under their corresponding listing site name. This resulted in 1057 public licenses. Because the same public license would sometimes occur in multiple listing sites strictly duplicate shortcodes were removed using the spreadsheet editor resulting in 780 public licenses. Removing the duplicates was not intelligent and left duplicates like ZPL-2.0 and ZPL - 2.0 as unique license shortcodes. The solution to this problem is presented in a later sub-chapter. The table in the state after the strict removal of duplicates is provided in this thesis' repository (Taguchi, 2025) under the name of `stage1-licenses.md`.

With the search for the initial license listing websites completed we moved onto the search

process itself.

2.3 Search process

The literature selection process was divided into multiple stages, as outlined in Figure 2.2. The initial step involved the formation of a inclusion and exclusion string through the use of a quasi-gold standard.

In the first stage, the search was conducted using the web pages titled ”MIT License” (Wikipedians, 2024b), ”SPDX License List” (Linux Foundation, 2024), ”The DFSG and Software Licenses” (Debian, 2024), FSF’s ”Category:License” Wiki page (FSF, 2024), GNU’s ”Various Licenses and Comments about Them” (GNU, 2023) and "OSI Approved licenses" (OSI, 2024) focusing, focusing on the license listing site name and shortcode. Then we identified and eliminated any duplicates, producing a preliminary set of potentially relevant literature. The dataset after the first stage of the search process is provided in this thesis’ repository (Taguchi, 2025) under the name of `stage1-licenses.md`, as mentioned earlier.

In the second stage, the inclusion and exclusion criteria were applied to further filter the literature and reduce the number of licenses to be reviewed. Then the resulting dataset was taken for a closer look where the quality of the literature was examined manually by the author, resulting in some manual exclusions based on the content and availability of the literature. This is where the inclusion and exclusion string took concrete place in which means the results were cross-referenced with the quasi-gold standard to validate it. The verbal reasoning for manual exclusions is clarified in Sub-chapter 2.4. The dataset after the second stage is provided in this thesis’ repository (Taguchi, 2025) under the name of `stage2-licenses.md`.

The third stage was the most time-consuming and involved a manual review of the full license texts. After reading and evaluating each license, a final round of exclusions was completed and documented. The remaining licenses were used for data collection and analysis in the final part of the study. The final list of licenses is available in Appendix A.

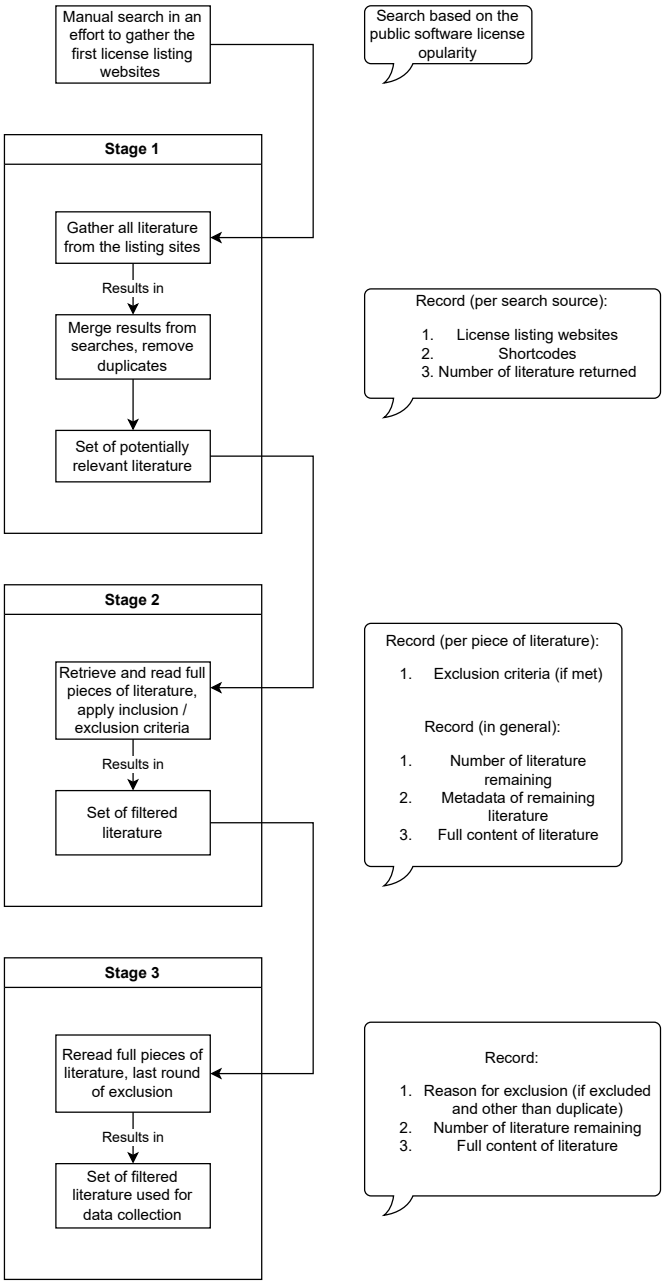

Figure 2.2: Search process divided into stages

2.4 Inclusion and exclusion criteria

Before we could apply the inclusion and exclusion criteria to the literature we had to fetch the full license texts from somewhere since the first stage's dataset included only the shortcode and listing site name. We decided that the public license database by ScanCode published in GitHub (ScanCode, 2025) was to be used fetching the initial full license texts based on the shortcodes of the first stage. The license database could be found by searching GitHub with the term "license database". The monolithic Python script used for this matching and fetching is provided in this thesis' repository (Taguchi, 2025) under the name of `methods.py`. Some shortcodes from the first stage did not match any full license texts from the license database. We had to manually fetch the missing full license texts from these license listing sites. The fetching was done systematically in cycles until no more missing full license texts were found with the help of the first stage spreadsheet. as can be seen from the Python script. We now had a complete Python dictionary with the shortcode as the key and full license text as the value.

To be eligible for the data collection and analysis, a license had to match the following inclusion and exclusion regular expression string:

```
^(?!.*\b(documentation\s+license|creative\s+commons|open data)\b).*
```

The regular expression string first included some inclusion matching but we soon realized it would be more efficient to exclude licenses than to include licenses. To establish the quasi-gold standard we first tried to exclude all full license texts including the words "creative commons" since we knew the Creative Commons licenses are not suitable for computer code, which is our scope. We then opened all excluded licenses into tabs in our text editor which the Python script assigned to their respective directory of excluded licenses based on the regular expression. We then looked quickly at the first few lines of the full license texts and judged if the license was indeed not suitable for our scope. Then we did the same to the included licenses in their respective directory and glanced if there were some types of licenses that were not suitable for our scope. We did one more cycle like this to finally exclude the string "documentation license" as well. During the two cycles we manually marked some licenses as included or excluded regardless of the regular expression matching since there did exist some corner cases the matching missed. This ended the second stage of search process which focused on inclusion and exclusion criteria.

#	Field	Concern/Research question
F1	Shortcode	RQ2, RQ3
F2	Listing site name	RQ1, RQ2
F3	Full text	Documentation

Table 2.3: Data extraction form

2.5 Data collection and data analysis

To answer the research questions of this thesis, a thorough examination of the selected primary literature was conducted and the necessary data was collected using data extraction form presented in Table 2.2. A record of the full license texts after the third stage was kept for anaysis and is available as a directory called `stage3-licenses` in the thesis' repository (Taguchi, 2025).

To get the necessary from the remaining literature we decided that the next reasonable step was to remove duplicates from the licenses as systematically as possible. We used Python's `difflib` library to sort the full license texts. The library itself used the Ratcliff and Obershelp algorithm compare every full license text to every full license text. The time complexity is $O(n^3)$ and $\theta(n^2)$. This took our working computer 68 minutes each time the algorithm ran so we decided to only do one cycle of this type of duplicate removal. The licenses were outputted to `duplicate-finding` directory with the naming convention of `n-shortcode.txt` where the n was the sort order given by the Ratcliff and Obershelp algorithm. We then opened these licenses to tabs in our text editor and compared the full license texts by human eyes if they were actually the same license with little to no noise difference in the full license texts. The comparison tool of our text editor was also a helpful automation tool for longer licenses that could not fit into one computer display as whole without scrolling. "open data" was also applied in the regular expression string at this stage. While this should have happened in stage 2, we wanted to be honest that this exclusion really did happen in stage 3. At this stage we also manually excluded individual licenses from the final dataset if there was too much noise. For example, GNU listed licenses often as whitespaces or something alike. Examples of these will be given in Chapter 3. This ended the third stage of the search process and provided us with the necessary data to answer the research questions.

The subsequent chapter presents the outcomes of the steps taken in the study, as discussed

above.

3 Results

This chapter employes the data extracted from the set of primary literature, available in this thesis' repository (Taguchi, 2025) under the name of `stage1-licenses.md`, utilizing the methods outlined in Chapter 2 to address the research questions. Firstly, a summary of the general statistics collected and aggregated from the studies is presented. Following that, an analysis of the data is performed to provide answers to each of the research questions.

To begin with, the publication year was not limited and could not have been limited in a rigorous way. Almost all of the public software licenses came from different sources although they were listed in the five license listing sites. To give a rough estimate, one of the earliest public software license aiming for legal compliance was the original GPL from 1989 (Bernelin, 2020). The search was carried out by web scraping all of the licenses from the five license listing sites without any filters to the attributes of the licenses. The initial search results included 1057 public licenses, but after the exclusion and quality criteria of software-only license scope, the final resulting dataset was reached.

Given the large starting dataset, a simple statistical overview of the literature was generated and is presented in Figure 3.1 and Figure 3.2 with the full list of literature available in this thesis' repository (Taguchi, 2025) under the name of `stage1-licenses.md`. The statistics highlight some immediate observations, such as the volume differences between the five sites and how the initial volume doesn't correlate to the amount of duplicate one site holds compared to the four others.

After establishing the quasi-gold standard and completing the preliminary study review outlined in Chapter 2, we systematically searched for relevant literature using the five license listing sites. The resulting search findings were filtered through a set of inclusion/exclusion criteria, followed by an extensive evaluation of quality before the final step of manual review. The final collection of literature consisted of 594 licenses, for which we obtained and reviewed the complete texts while completing the data extraction form as presented in Table 2.1. To enhance transparency of the process, Figure 3.3 illustrates the progression of literature through each stage. We observed the number of literature acquired is adequate to gain an representative overview of the field, which we will explore further in this chapter.

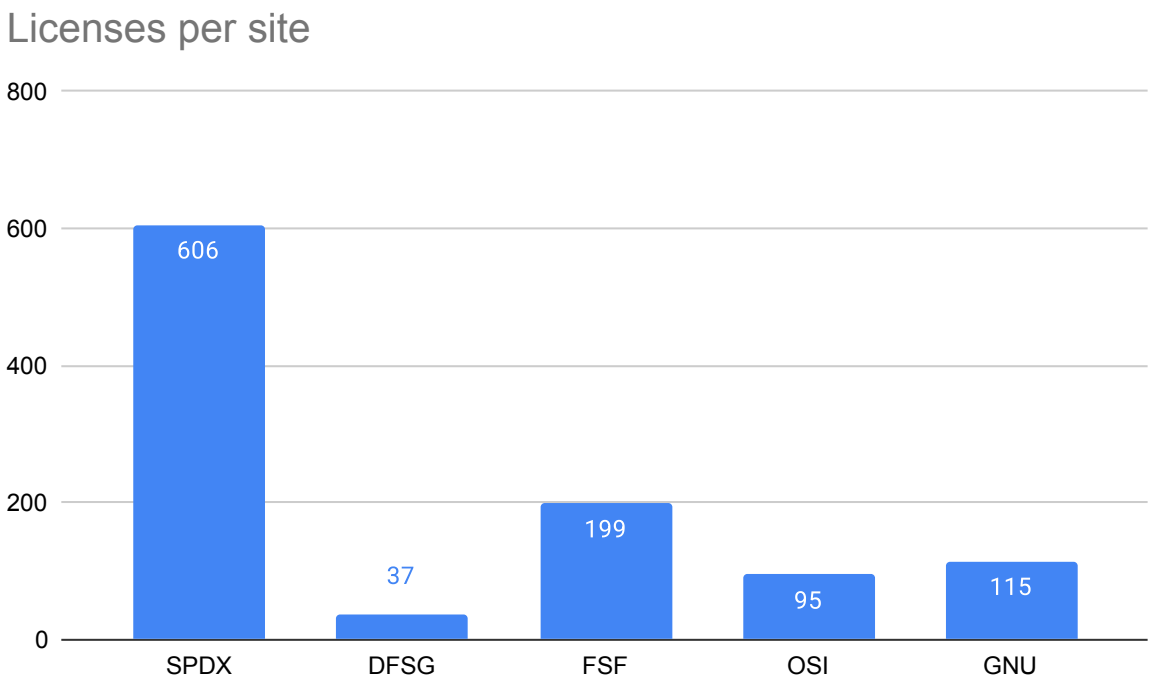

Figure 3.1: Statistics about the original 1057 licenses

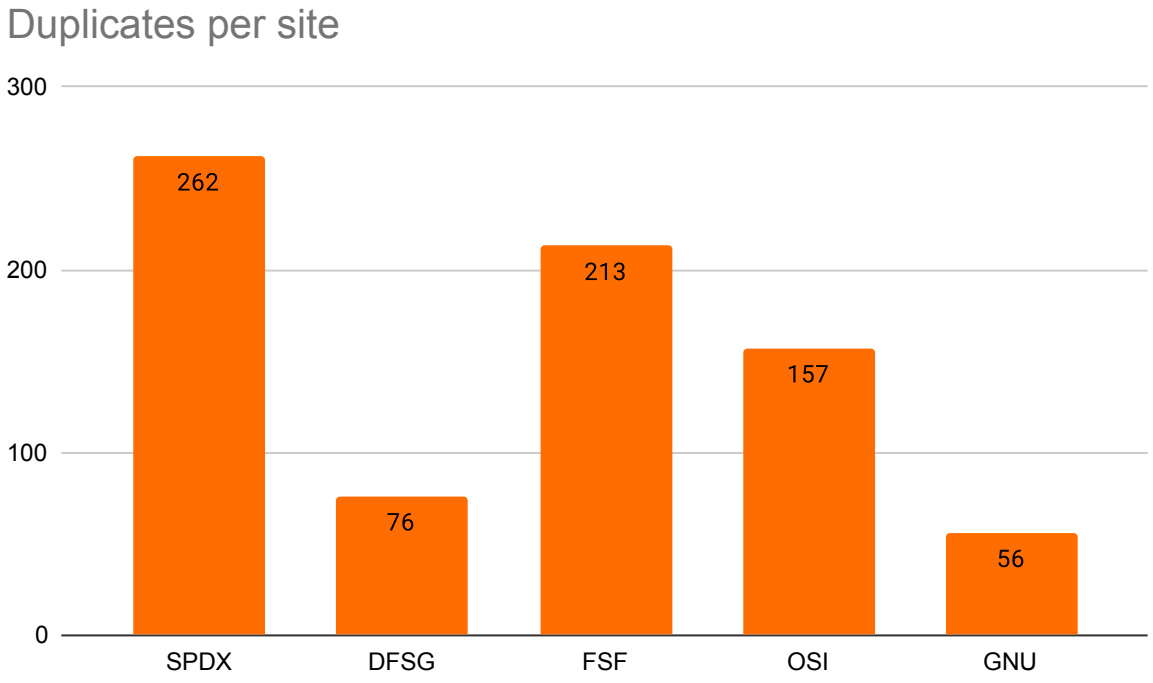

Figure 3.2: Duplicate statistics about the original 1057 licenses

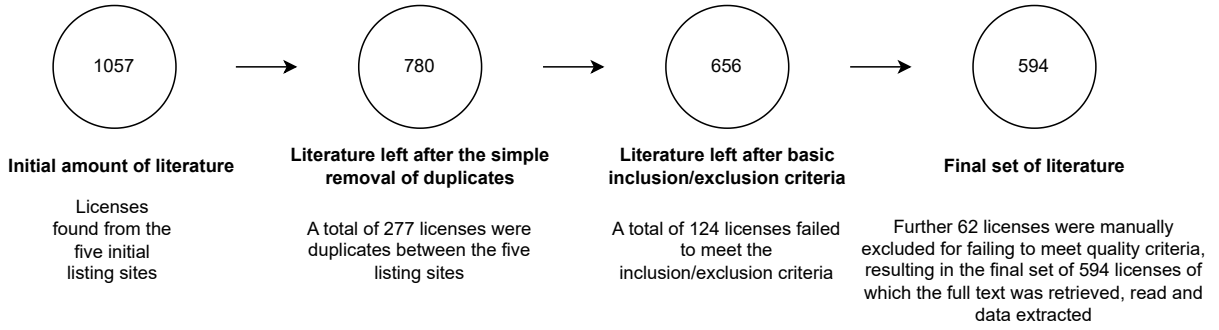

Figure 3.3: Number of literature per step of data collection

After this overview let us take a look into the specific research questions and their answers.

3.1 Five license listing sites and their licenses (RQ1)

Only license listing site during the first phase of the search process that did not give too much trouble was the SPDX. This was mostly be due to the table format used in that particular license listing site, shortcode identifier being provided inside that table and that it seems that SPDX preserves many of the licenses regardless of legal validity, superseding licenses or voluntary retirement.

The four other listing sites were more problematic to scrape. An example of DFSG is that for example for the license ”Licence Art Libre (Free Art License)” I had to just use the more commonly used shortcode `FAL` because the shortcode itself was not listed in DFSG. FSF used a Wiki as the base for the license listing site so there was plenty of missing and outdated data. For example the original `Python` license has the full text of just ”test” which indicates a pure mistake or a placeholder from the FSF. OSI had licenses that were retired between the search stages one and two. For example `cvw` was listed during the initial web scraping of the five listing sites but during the full license text fetching from the public license database of ScanCode the original creator of `cvw`, MITRE had voluntarily retired their license from the OSI license listing site and was no longer found from the OSI license listing site even though the missing license was noted to be from the OSI in the spreadsheet. The license was found however under the shortcode `cvwl` from the ScanCode public license database. This specific issue could have been solved by using an internet archiver, which we will discuss further in Chapter 4. GNU for example listed licenses like `attpubliclicense` which pointed the full license text to reside in and FSF site but the full license text was empty. In this case we had to just use the comments

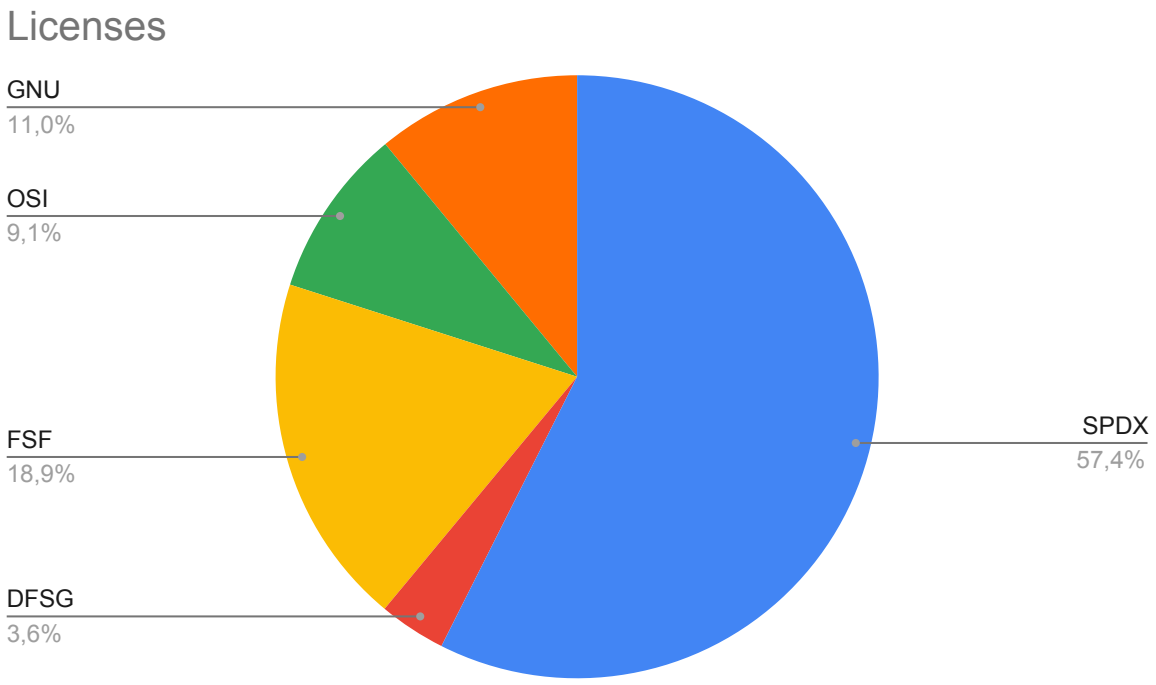

Figure 3.4: Distribution of license across the listing sites

made by GNU as the full license text in this thesis.

These are just individual examples of the level of maintenance appearing in the four other license listing sites and some other examples will be brought up later in the next chapter. This is because solving these problems also becomes more of a validity threat of the author regardless of the fact that this kind observation is a relevant result on its own in this thesis. When we count the amount of license per listing site after search stage one we get 607 licenses from the SPDX, 38 from the DFSG, 200 from the FSF, 96 from the OSI and 116 from GNU. The distribution of licenses from the five listing sites is illustrated in Figure 3.4.

3.2 Duplicates in license listing sites (RQ2)

A total of 463 CONTINUE HERE

3.3 Total amount of public software licenses (RQ3)

the eye-pass of 87 excluded licenses included cal1.0 and cal-combined which seem to need to be included. made inclusions.txt to manually include them although containing the words creative commons, since those license texts were licensed themselves with creative commons. will eyeball the stage-2 shortcodes as well just to see anything i know by heart is not public software license. cc-by-sa-japanese was included so i had to make a manual exclusions.txt to manually mark licenses that are not public software licenses.

A notable observation regarding the total amount of existing public software licenses is that many of the licenses might not be considered legally valid in any court and many of them do not even try to be legally valid in the court. An example of the former, possibly not court-fireproof software license is the `MIT`. The breach of the license is not meant to be settled in court but rather just agreeing developer to developer that the distributed software contains MIT -licensed source code. Some examples of the latter include `Beerware` and `JSON` from which the former recommends buying a licensor a cold beverage and the latter forbids the use of software to evil purposes.

4 Discussion

indications

follow-up observation

observation 1

observation 2

sum-up from those two

4.1 Implications for research

how to improve scientific scene 1

how to improve scientific scene 2

how to improve scientific scene 3

4.2 Implications for software engineering professionals

how to improve professional scene 1

how to improve professional scene 2

how to improve professional scene 3

overall

4.3 Limitations and threats to validity

PUT THIS HERE OR THE SECTION BELOW Some things must be mentioned about the process of the first stage. First, the FSF outputted a ”license” named ”other”. This ”license” included at the time of observation 5282 known programs to FSF whose PCLs were not documented yet by the FSF. Although some of the programs had straightforward

PCLs such as GPL-2.0-only we decided to leave these PCLs out of the scope of this thesis due to the large amount of the programs. The second note is about GNU's PCLs. Since we had the most trouble scraping the identifiers automatically from this website we decided to limit the PCLs only to "Software Licenses" as defined by the table of contents on the website.

SAME THING HERE approx duplicates were the result of going to the two listing websites that had the approaximately same looking licenses. then i just checked if they were actually some sort of duplicates of one another or if they already exist somewhere else. examples here. this is also a validity threat. problem with focusing software specific licenses is for example wtfpl. it is mostly used in software licensing but it doesn't quite clearly state that it is software specific license. maybe ill have to include the word "public license" and just include stuff that's not actually software specific or maybe ill make some exclusion criteria in order to get less non-software licenses

the order of wikipedia infobox was used for missing licenses so a validity threat and for the de-duplication in stage 2 and some other parts of the thesis you must declare. second stage licenses were fetched from scancode licensedb on 2025 mar 25 15:30

. dejavu and dbg-3.0 were also two other licenses that contained a space. this might indicate that the space is an accident that its simply just not found from a license listing site x. its also good to note that the python script was decided to be an valid approach since many of the licenses were actually found with the shortcode from the licensedb scancode. fetching 700 licenses by hand would have had time and validity issues. wayback machine could have been used to do the actual searching as well. this is unfortunately a validity issue but at least the source is available in wayback machine.

it seems like i have manually added licenses and invented shortcodes for them AT LEAST in DFSG license listing. FAL is a good example. many of the validity threats also are presented in 2.methods and 3 results like the fal free art license come upwith the shortcode from fsf and are not mentioned here again for redundant repetition.

For example licenses like CorkForkPL from FSF are just empty licenses. CorkForkPL is used however in MighTyD project but the license would have to be seen from a downloaded project or something like that. A new scope: only licenses that are one (1) click away from the initial license landing page can be copypasted to the manual licenses. just like the JahiaCSL has a URL on FSF for the license new location although the FSF page is empty.

licenses like MPL exist on FSF and GNU. it was not easily found from FSF (empty with links to programs using this) so it was gotten from GNU which was labeled as MPL1.1, which the FSF DOES have so i just boldly went with that. threat to validity.

its good to note that systematic != automatic. our approach especially uses automation (python) to help the author use their human eye sight otherwise it would be more prone to error due to the large amount of licenses

documenting missing licenses amount from their respective site was not possible since the missing licenses were just fetched in the wikipedia order so if SPDX was a hit we would never know if it was missing from the other site i.e. wrong shortcode or completely just missing. most of the missing licenses were by a feel of the author from fsf and gnu in that order. it was a good realization to invent that the goal of the thesis was not to fix the organization issues of the 5 listing sites but rather to, again, point out the madness of having so many open source licenses. same realization goes for the difficulity of making the automation tool

"(source|software|program|code|module|public(s+)license|ware|(w+)ware)" was the first inc exc regex i used and it caught stuff like gfdl and thats how i ended up using exclusion only. note that documentation is not software but for example font is

python script does not work on windows machine due to some os dependent path problems - validity threat

remember to document the validity L of human eye sight used majorly on third stage of search process. duplicate removal in tabs was done so that: i check the text if the n and n+1 and if they look pretty much the same i act and if the shortcodes look the sam i act.

The major limitation of this study is that the subjective results could not be validated by multiple researchers. In a systematic review, it is standard practice and highly recommended to have at least two, if not more, individuals independently conduct the review processes and then cross validating the findings. This would result in the possibility of comparing individual exclusion decisions and other decicions, thereby increasing the credibility of the study. However, in this study, the methodology was thoroughly documented, which allows us to assert with confidence that the study has an appropriate level of of validity.

As a work of single researcher, there is also a chance of inaccuracy and bias in the literature selection and filtering process. As much of the literature had to be reviewed manually and

then included/excluded on a qualitative basis, this is a known limitation and a threat to validity. Multiple rounds of documented filtering and a clear paper trail of all decisions made keeps this threat in the acceptable levels.

4.3.1 Limitations of literature selection for review

Efforts were made to ensure the inclusion of comprehensive set of literature in the search process. This was achieved by setting the starting point of PCL lists to the Wikipedia article of the MIT license.

However, as with all systematic literature reviews, a comprehensive manual review of all literature would have been a formidable task. Therefore, additional filtering was conducted. This filtering was carried out in two phases, starting with the application of inclusion/exclusion criteria, followed by a second phase focused on evaluating the nature of the PCLs and conducting a manual review. As a result of this second phase, a set of literature were excluded following a critical appraisal, with documentation and reasoning provided for each section.

The first phase of filtering has some notable limitations starting with the two PCL listing websites: SPDX and DFSG. Since the material was gathered to a spreadsheet program the duplicates were removed using the short identifier the listing page was using. Let's look at this validity threat using an example. Suppose our spreadsheet program has acquired the PCL with an identifier "MIT". The results of phase 1 will not include any other PCL marked with the identifier "MIT". In the worst case the identifier "MIT" could have actually been "MIT-DFSG-edition" but with the identifier of "MIT". Since there were so many PCLs in phase 1 it would not have been possible to check the uniqueness of all removed duplicates. One of the reasons why this would not have been feasible is that the listing sites would fetch the PCL contents from another webpage or at the second worst case, from another website. The worst case is that the URl is dead and we get HTTP 404. The amount of PCLs, duplicates and the lack of already existing tools makes this problem multilayered. However this is the integrity level we decided to live with.

FSF's PCL listing introduced us to pick another limitation for the scope of this thesis. The license shortcoded as "other" was not a PCL but instead a hyperlink to another listing webpage that listed programs that the FSF has no yet managed to document the license which the program uses. Although the one of the programs called "babl" was licensed as with "gplv3" the amount of undocumented programs was over 5200 at the

time of observation. For this reason we are excluding the PCLs found indirectly from the category ”other”.

tell about the validity threats of osi literature selection for review

Lastly, GNU project's listing site allowed us to use a shortcut of sorts which we will document here for the purposes of acknowleding the limitations of it. The table of contents at the listing site marked certain consequtive PCLs as software PCLs. On top of this the PCLs were not organized into easily processable tables but rather in stacked on one another in rich text format. Although we decided to use regex on the HTMl file the included PCLs were only the ones that were simply under the header ”Software licenses”. In the worst case scenario GNU project could have misinterpreted some PCLs as non-software licenses thus making this thesis exclude them with a wrong reason. While from a quick glance and the existence of the other four PCL listing sites, we think it is still worth documenting when it comes to validity and the integrity of this thesis.

On top of too heavy filters we would also like to document the too light filters in the literature selection for review. We can see from Appendix A that for example PCLs with the literature identifiers L777 and L780 are almost the same regarding the shortcoded identifiers: ”ZPL - 2.1” and ”ZPL-2.1”. The duplicate removal would have been seemingly simple to execute on phase 1. However with the presence of over 700 pieces of literature we decided not to give special treatment to any potential set of duplicates. While it is most possible that OSI's ”ZPL - 2.1” is equivalent exactly to SPDX's ”ZPL-2.1” we could not be sure without looking at their contents. This could have resulted duplicate PCLs in the literature selection for review but these type of duplicates are removed in phases 2 and 3 due to the PCLs being read in full.

As such we can note that the literature selection was done in a sufficient manner.

4.3.2 Limitations in data extraction

importance of data extraction

lack of measurements and tooling

5 Conclusions

primary objective of this study

conclusions from each rq

5.1 Future research

adopting a clear baseline the most used licenses are most probably legally invalid to use or not mean to be legally valid (mit) rather than all of these 600+ licenses are legally binding and bullet-proof

why agplv3re is the best license

Docker CLA, SSPL

make cla easier maybe with gpg / joplin easy cla sign

LICENSE highlighting.js

what kind of efforts and why

what this thesis has provided

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Appendix A Primary literature reviewed, read in full and data extracted

Table A.1: Final list of literature with the inclusion/exclusion criteria applied.

Literature identifier	Shortcode	SPDX	DFSG	FSF	OSI	GNU
L1	0BSD	SPDX			OSI	
L2	996			FSF		
L3	AAL	SPDX			OSI	
L4	Abstyles	SPDX				
L5	ACEL			FSF		
L6	AdaCore-doc	SPDX				
L7	Adobe-2006	SPDX				
L8	Adobe-Display-PostScript	SPDX				
L9	Adobe-Glyph	SPDX				
L10	Adobe-Utopia	SPDX				
L11	ADSL	SPDX				
L12	AFL-1.1	SPDX				
L13	AFL-1.2	SPDX				
L14	AFL-2.0	SPDX				
L15	AFL-2.1	SPDX				
L16	AFL-3.0	SPDX		FSF	OSI	
L17	Afmparse	SPDX				
L18	AGPL-1.0-only	SPDX		FSF		
L19	AGPL-1.0-or-later	SPDX		FSF		
L20	AGPL-3.0-only	SPDX	DFSG	FSF	OSI	
L21	AGPL-3.0-or-later	SPDX		FSF		
L22	Aladdin	SPDX		FSF		GNU
L23	Aladdin-9			FSF		
L24	AMDPLPA	SPDX				
L25	AML	SPDX				
L26	AML-glslang	SPDX				
L27	AMPAS	SPDX				

L28	ANTI-1.3			FSF		
L29	ANTI-1.4			FSF		
L30	ANTLR-PD	SPDX				
L31	ANTLR-PD-fallback	SPDX				
L32	Apache-1.0	SPDX		FSF		
L33	Apache-1.1	SPDX		FSF	OSI	
L34	Apache-2.0	SPDX	DFSG	FSF	OSI	
L35	APAFML	SPDX				
L36	APL-1.0	SPDX			OSI	
L37	App-s2p	SPDX				
L38	APSL-1.0	SPDX		FSF		
L39	APSL-1.1	SPDX		FSF		
L40	APSL-1.2	SPDX		FSF		
L41	APSL-2.0	SPDX	DFSG	FSF	OSI	
L42	Arphic-1999	SPDX				
L43	Artistic-1.0	SPDX		FSF	OSI	
L44	Artistic-1.0-cl8	SPDX				
L45	Artistic-1.0-Perl	SPDX		FSF	OSI	
L46	Artistic-2.0	SPDX	DFSG	FSF	OSI	
L47	ASWF-Digital-Assets-1.0	SPDX				
L48	ASWF-Digital-Assets-1.1	SPDX				
L49	ATTPublicLicense					GNU
L50	Baekmuk	SPDX				
L51	Bahyph	SPDX				
L52	Barr	SPDX				
L53	bcrypt-Solar-Designer	SPDX				
L54	Beerware	SPDX				
L55	BerkeleyDB					GNU
L56	Bitstream-Charter	SPDX				
L57	Bitstream-Vera	SPDX				
L58	BitTorrent-1.0	SPDX				
L59	BitTorrent-1.1	SPDX		FSF		
L60	blessing	SPDX				
L61	BlueOak-1.0.0	SPDX			OSI	
L62	Boehm-GC	SPDX				

L63	Borceux	SPDX			
L64	Brian-Gladman-2-Clause	SPDX			
L65	Brian-Gladman-3-Clause	SPDX			
L66	BSD-1-Clause	SPDX		FSF	OSI
L67	BSD-2-Clause	SPDX		FSF	
L68	BSD-2-Clause-Darwin	SPDX			
L69	BSD-2-Clause-FreeBSD			FSF	
L70	BSD-2-Clause-Patent	SPDX			OSI
L71	BSD-2-Clause-Views	SPDX			
L72	BSD-3-Clause	SPDX	DFSG	FSF	OSI
L73	BSD-3-Clause-acpica	SPDX			
L74	BSD-3-Clause-Attribution	SPDX			
L75	BSD-3-Clause-Clear	SPDX		FSF	
L76	BSD-3-Clause-flex	SPDX			
L77	BSD-3-Clause-HP	SPDX			
L78	BSD-3-Clause-LBNL	SPDX			OSI
L79	BSD-3-Clause-Modification	SPDX			
L80	BSD-3-Clause-No-Military-License	SPDX			
L81	BSD-3-Clause-No-Nuclear-License	SPDX			
L82	BSD-3-Clause-No-Nuclear-License-2014	SPDX			
L83	BSD-3-Clause-No-Nuclear-Warranty	SPDX			
L84	BSD-3-Clause-Open-MPI	SPDX			
L85	BSD-3-Clause-Sun	SPDX			
L86	BSD-4-Clause	SPDX		FSF	
L87	BSD-4-Clause-Shortened	SPDX			
L88	BSD-4-Clause-UC	SPDX			
L89	BSD-4.3RENO	SPDX			
L90	BSD-4.3TAHOE	SPDX			
L91	BSD-Advertising-Acknowledgement	SPDX			
L92	BSD-Attribution-HPND-disclaimer	SPDX			
L93	BSD-Inferno-Nettverk	SPDX			
L94	BSD-Protection	SPDX			
L95	BSD-Source-beginning-file	SPDX			
L96	BSD-Source-Code	SPDX			

L97	BSD-Systemics	SPDX			
L98	BSD-Systemics-W3Works	SPDX			
L99	BSL-1.0	SPDX		FSF	OSI
L100	BUSL-1.1	SPDX			
L101	bzip2-1.0.6	SPDX			
L102	C-UDA-1.0	SPDX			
L103	CAL-1.0	SPDX			OSI
L104	CAL-1.0-Combined-Work-Exception	SPDX			
L105	Caldera	SPDX			
L106	Caldera-no-preamble	SPDX			
L107	CATOSL-1.1	SPDX			
L108	CDDL-1.0	SPDX		FSF	
L109	CDDL-1.1	SPDX			
L110	CDLA-Permissive-1.0	SPDX			
L111	CDLA-Permissive-2.0	SPDX			
L112	CDLA-Sharing-1.0	SPDX			
L113	CECILL-1.0	SPDX			
L114	CECILL-1.1	SPDX			
L115	CECILL-2.0	SPDX		FSF	
L116	CECILL-2.1	SPDX			OSI
L117	CECILL-B	SPDX			
L118	Cecill-B-v1			FSF	
L119	CECILL-C	SPDX			
L120	Cecill-C-v1			FSF	
L121	CERN-OHL-1.1	SPDX			
L122	CERN-OHL-1.2	SPDX			
L123	CERN-OHL-P-2.0	SPDX			OSI
L124	CERN-OHL-S-2.0	SPDX			OSI
L125	CERN-OHL-W-2.0	SPDX			OSI
L126	CFITSIO	SPDX			
L127	check-cvs	SPDX			
L128	checkmk	SPDX			
L129	ClArtistic	SPDX		FSF	
L130	Clips	SPDX			
L131	CMU-Mach	SPDX			

L132	CMU-Mach-nodoc	SPDX			
L133	CNRI			FSF	
L134	CNRI-Jython	SPDX			
L135	CNRI-Python	SPDX			OSI
L136	CNRI-Python-GPL-Compatible	SPDX			
L137	COIL-1.0	SPDX			
L138	Commons-Clause			FSF	
L139	Condor-1.1	SPDX		FSF	
L140	copyleft-next-0.3.0	SPDX			
L141	copyleft-next-0.3.1	SPDX			
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L143	CPAL-1.0	SPDX	DFSG	FSF	OSI
L144	CPL-1.0	SPDX	DFSG	FSF	OSI
L145	CPOL-1.02	SPDX		FSF	
L146	Cronyx	SPDX			
L147	Crossword	SPDX			
L148	CryptixGL			FSF	
L149	CrystalStacker	SPDX			
L150	CUA-OPL-1.0	SPDX			
L151	Cube	SPDX			
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L153	cvw				OSI
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L159	DL-DE-ZERO-2.0	SPDX			
L160	DOC	SPDX			
L161	Dotseqn	SPDX			
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L163	DRL-1.1	SPDX			
L164	DSDP	SPDX			
L165	dtoa	SPDX			
L166	dvipdfm	SPDX			

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L169	ECos-2.0			FSF	OSI	
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L172	eGenix	SPDX				
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L174	Entessa	SPDX				
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L176	EPL-1.0	SPDX	DFSG	FSF	OSI	
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L212	GPL-2.0-or-later	SPDX		FSF		
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L244	IBMPL					GNU
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L250	iMatix	SPDX		FSF		GNU
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L254	informal					GNU
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L264	Jam	SPDX			OSI	
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L266	JOSL-1.0			FSF		
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L268	JPNIC	SPDX				
L269	JSON	SPDX	DFSG	FSF		GNU
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L271	Kazlib	SPDX				

L272	Knuth-CTAN	SPDX				
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L275	LaTeX ecfonts			FSF		
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L281	LGPL-2.1-only	SPDX		FSF		
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L283	LGPL-3.0-only	SPDX	DFSG	FSF	OSI	
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L290	libtiff	SPDX				
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L298	Linux-man-pages-copyleft-var	SPDX				
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L316	Mackerras-3-Clause-acknowledgment	SPDX				
L317	magaz	SPDX				
L318	mailprio	SPDX				
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L373	NIST-Software	SPDX				
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L411	OLDAP-2.3	SPDX		FSF		

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L424	OpenVision	SPDX				
L425	OPL-1.0	SPDX	DFSG	FSF		
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L445	Plexus	SPDX				
L446	pnmstitch	SPDX				

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L457	Python-2.0.1	SPDX		FSF		
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L476	SchemeReport	SPDX				
L477	Scilab-old			FSF		
L478	Scratch			FSF		GNU
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L484	SGI-B-2.0	SPDX		FSF		
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L489	SHL-0.51	SPDX				
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L493	SimplePermissiveNoNonWarranty			FSF		
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