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"PUBLIC SECTOR READINESS FOR OPEN-SOURCE SOFTWARE ADOPTION"

Master's Thesis

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PhD

Tallinn 2023

TALLINNA TEHNIKAÜLIKOOL

Infotehnoloogia teaduskond

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"AVALIKU SEKTORI VALMISOLEK AVATUD LÄHTEKOODIGA TARKVARA RAKENDAMISEKS"

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Author's declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature, and the work of others have been referred to the best of my knowledge and ability. This thesis has not been presented for examination anywhere else.

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08.05.2023

Abstract

Open-source software (OSS) is seen as the key to the sovereignty and sustainability of the digital ecosystem of the public sector. Nevertheless, several legal and governance obstacles impede its successful adoption. The major challenge is the absence of clear instructions and a comprehensive list of simple adoption principles. The main objective of this study is to analyze OSS adoption sustainability in the list of data collection countries and provide valuable insights that could help organizations in the public sector make informed decisions about adopting open-source software solutions. The study utilizes a comprehensive qualitative approach to collect diverse data and address research objectives. As a result of the research, the findings reveal the main influencing principles behind successful OSS adoption and recommend the list of critical governance assessment criteria which subsequently could impact sustainable OSS adoption in the public sector.

Keywords: Open-source software (OSS), OSS Adoption Principles, Open-Source Governance

This thesis is written in English and is 54 pages long, including 6 chapters, 10 figures and 3 tables.

List of abbreviations

OSS	Open-Source Software
OSI	Open Source Initiative
OSOR	Open Source Observatory
OSD	Open-Source Definition
FOSS	Free Open Source Software
TCO	Total Cost of Ownership
TS of CS	Treasury Board of Canada Secretariat
MCIT	Ministry of Communication & Information Technology
I2IT	International Institute of Information Technology
GNU	Gnu's Not Unix

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1. Introduction

1.1 Overview of Research

This research aims to decrease the uncertainty gap around open-source software (OSS) adoption and provide public sector officials with practical legal and governance recommendations. The research findings are expected to guide public sector project planning and decision-making, resulting in a more efficient and sustainable adoption of OSS. Using this study, the public sector may ensure that its initiatives follow accepted governance principles, reduce the risk of potential challenges, and ultimately accomplish its digitalization objectives.

OSS is free and open collaborative software, which can be used, implemented and changed for any purpose, nowadays can be found in most governmental policies, initiatives and digital masterplans. The public sector strives to adopt OSS to release themselves from proprietary owned, vendor-locked software to enhance digital autonomy and cost-efficiency and introduce complete transparency. Moreover, it is seen as the key to the sustainability of the digital ecosystem and multistakeholder collaboration. However, even though the potential of OSS, specifically in the public sector, seems reasonable, many countries are still in the very *ad-lib* implementation phase, often seeking guidance and practical prerequisites to follow.

Although the term OSS was introduced in 1998 (Fitzgerald, 2006), the reinforced creation of an ecosystem around OSS in the public sector is a relatively new concept. The governments are expected to gain from external input and speed up innovation and development while sharing the costs and risks with the ecosystem by releasing the platform under an open license and using an available collaborative method for platform development (Linåker & Runeson, 2020). Regardless, for newly-launched OSS users, developing an open, operating ecosystem and converting to a transparent and collaborative development model is a relatively continuous maturity process regarding internal culture, procedures, and organizational structure (*Ibid.*). Potential frictions during the maturity phase are very common but beneficial at a later stage. Constantly evolving multistakeholder initiatives for digital transformation accelerators require diverse readiness prerequisites for open-source to implement the improved solutions.

The European Commission (2020) finds that the open-source strategy is in robust correlation with the digital strategy, which will unambiguously affect Europe's digital sovereignty. The open code approach is believed to allow governments to join forces and reuse operating "success" stories while eliminating the need to tackle vulnerabilities and reinventing operational practices. Furthermore, such an ecosystem is expected to support the collaboration between the member countries and co-create solutions to effectively support the public sector and the country's citizens' needs (*Ibid*.). Despite the broadcasted benefits, the government adoption of OSS is relatively slow and even results in switching back to proprietary solutions due to unsustainable processes and issues with collaboration and adaptability (Sowinska *et al*., 2021).

To adhere to the OSS approach, as a start, governments have to adjust and examine the level of regulations, infrastructure, potential legacy system exit costs, availability of expert consultants, procurement and acquisition decisions and maturity of the software support (Shaikh, 2016). Considering the mentioned aspects, it is clear that switching from the familiar "classics" will require a tremendous workload, time, resources and a budget, whereas the latter might or not regain its value back. Furthermore, as per Loon & Toshkov (2015), the success of OSS adoption is also significantly affected by political strategy and the character of the published policy. The acceptance and implementation rate will be relatively low if policy adoption is made optional. Therefore, the OSS adoption shall be continuously promoted through the top-down approach and might require more direct appeal from the public sector.

As a consequence of the problematic adoption of OSS in the public sector, Offerman (2012) has brought up the main issues of procurement based on the expertise of Spain, France and the UK. The open-source representatives of the mentioned countries have highlighted in unison the small scale of open-source providers' capability, often being medium-sized firms which can not satisfy the broad scope of governments' needs. There are very few specialists who can maintain such a community and qualify for direct tender from the government (*Ibid*.). Subsequently, the governments shall change their views towards the lack of available solutions and expertise and focus on developing a decentralized open solution. Such an ecosystem will only succeed with external expertise. It might create an excellent ground for digital collaboration between the private and public sectors, as the latter needs to catch up. OSS development can be an exemplary

compound of the "private-collective" innovation model and synthesize collective action to pursue a common cause and bring the "best of two worlds" together (Hippel & Krogh, 2003).

1.2 Context Description

1.2.1 OSS Definition

Based on the coined definition adopted in 1998 in Palo Alto, California, "open-source software is software that can be freely accessed, used, changed, and shared (in modified or unmodified form) by anyone" (OSI, 2023). The essential definition conditions include several "must have" aspects, and misinterpreting at least one could result in the Open Source Initiative (OSI) denying official license approval. OSI defines open-source software as software that satisfies the following criteria (OSI, 2023; Gin, 2019; Rahman, 2008; (Laurent, n.d.):

Table 1. OSS definition criteria.

Criteria	Description
Free Redistribution	The license should permit the sale or distribution of the software as part of a set of programs from various authors.
Source Code	The software must include the source code and permit both source code and compiled form distribution.
Derived Works	The license has to allow modifications and derivative works to be distributed under the same conditions as the original software license.
Integrity of Author's Source Code	If "patch files" are made accessible for modifying the program at build time, the license may prohibit the dissemination of updated source code.
No Discrimination Against Persons	The license cannot be discriminatory toward any individual or group of individuals.
No Discrimination Against Fields	The license cannot restrict the use of the program to a particular industry.
Distribution of License	Every software recipient should be entitled to use it by rights outlined in the license without signing a separate license.
License Must Not Be Specific to a Product	The license should not be contingent on the software's inclusion in a particular distribution.

License Must Not Restrict Other Software	The license should not impose limitations on additional software delivered alongside the licensed program.
License Must Be Technology-Neutral	The license should not depend on a specific technology or user interface type.

Throughout the OSS concept definition maturity, the community has experienced numerous conflicts due to the initial founding partners' differing campaign values. For example, Richard Stallman, a controversial activist and the founder of the Free Software Foundation (FSF), has advocated for "free software" as "freedom of use". Meanwhile, Stallman has accused OSI of being ignorant of the definition's initial guiding principles and the economic interest stake (Miller *et al*., 2010). Also, his proponents saw it as overly concerned with technical efficiency at the price of social fairness and user empowerment and a questionable emphasis on theoretical rather than practical advantages.

It is important to note that both communities have made significant contributions to the world of software development and the quality and enhancement of open-source software. Therefore, the organization considering OSS adoption must evaluate the suitable strategy based on the organization's internal objectives and values. In the context of this study, the author researches OSS as a conceptual tool for the digitalization of the public sector without a deliberate decline toward any particular software development community.

1.2.2 Source Code Providers Licenses

Source code licenses are legal contracts which list conditions for using, modifying, and distributing OSS software (Laurent, n.d.). The two primary OSS license types are permissive licenses and share-alike licenses. The primary difference between these two license types is that permissive licenses permit the use of software for proprietary purposes. In contrast, share-alike licenses mandate that any modifications or derivative software versions be released under the initial license type.

Permissive licenses do not restrict users from modifying and distributing software as needed, nor are they required to share their modifications or derivative works under the same license type. For example, the software released under this license may be incorporated into proprietary software without releasing the source code to the public.

The most known permissive licenses are MIT, Apache, and BSD (Garcia, 2023; Sashidharan, 2023).

Share-alike or copyleft licenses require developers to distribute and publish all issued modifications under the initial license type (FOSSA, 2021). This requirement ensures that any modifications made to the software remain accessible to everyone. For example, the GNU General Public License and the Creative Commons Share-Alike License mandate the abovementioned functionality (Garcia, 2023).

1.4 Research Motivation and Relevance

The author's research motivation has been initiated by the participation in the multistakeholder GovStack[1] initiative, which highlighted the necessity of clear and straightforward governance over OSS adoption in the public sector. The potential participant countries which strive for digital transformation have faced numerous challenges trying to alter offered digital public infrastructure due to the absence of flexible legislation and governance readiness to adopt the abovementioned type of software on the governmental level.

Furthermore, the transition of OSS into the public sector's essential functions has been noticed worldwide, and the list of practical case studies is constantly evolving. For example, in September 2022, European Commission announced its first git code repository for the European institutions and has stated the legitimate direction towards "an organization that consumes open-source to one that builds its solutions on open-source, to ultimately a Commission that is closely involved in open-source" (OSOR, 2022).

Publicly available academic researches include the overview of technological, organizational and economic prerequisites for OSS adoption only. As per Sánchez *et al*. (2020), recommended technological prerequisites include compatibility, reliability and usability. The complete switch to an entire OSS approach in the organization during the first phase is implausible. Therefore there is a need to determine if the chosen OSS solution will be compatible with proprietary solutions already in place (*Ibid.*).

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[1] https://www.govstack.global/about/

Furthermore, the OSS's reliability and usability must be evaluated as this significantly affects the acceptance rate. Suppose the reliability of a specific OSS does not seem self-explanatory. In that case, IT management has to diligently introduce the benefits to the team and support them during the whole familiarization journey. New members of the OSS community should also maintain a high-quality source code and provide solid support to its open community and product maturity (Sowinska *et al.*, 2021).

Based on the review, organizational prerequisites consist of support, training and attitude towards change (Sánchez *et al.*, 2020). Adoption of OSS requires continuous competent technical support as lack of that may fail in the adoption. Training and attitude towards change are strongly correlated, as the first one, in case of a correct delivery, may enhance the attitude towards the substitute process and eliminate adverse outcomes. The organization has to be ready to be part of OSS's vibrant community and contribute to expertise sharing, events and the creation of new growth opportunities (Sowinska *et al.*, 2021).

Lastly, economic prerequisites include the total cost of ownership, operational cost and support (Sánchez *et al.*, 2020). In different organizations, these are calculated, in unlike ways, as some consider it one aspect, while others prefer to calculate it separately. The cost-efficient licensing cost is often the main factor for adopting complete OSS infrastructure. However, such change requires high exit costs and must be thoroughly evaluated immediately. Sustainable funding will help support the entire OSS life cycle and secure expected maintenance (Sowinska *et al.*, 2021).

Considering the above, a thorough review of the legislative and governance background of OSS adoption is crucial for the further success of the open-source software implementation journey and digital transformation initiatives as the abovementioned GovStack project. This research can provide the industry with the material to ensure awareness and simplified ground for the subject's adaptation.

1.5 Problem Statement

OSS has become a popular alternative for proprietary software due to an increasing need for new, affordable and effective solutions. Nevertheless, several obstacles impede its

general adoption. For example, there need to be more explicit instructions and a comprehensive list of simple governance over this subject. In addition, public sector organizations face significant challenges during the adoption phase, often due to a need for subject awareness, a solid local community and the required infrastructure.

Another significant obstacle is the need for governance certainty and guidelines to support governments using OSS. Although many countries have acknowledged the potential advantages of OSS, they frequently need help adopting it into action due to a need for clear regulations and support. Potential adopters may be discouraged due to the uncertainty and confusion this may cause on matters like cost misconception, intellectual property protection and licensing.

Additionally, the open-source community needs guidelines, making it easier for organizations to select the best software and its license type for their needs. Compatibility problems and the need for extensions, which can be expensive and time-consuming, come from this. These issues highlight the need for more OSS education, awareness and the creation of clear legal frameworks and consistent governance principles. Once it succeeds, OSS may be considered a strong choice for the public sector worldwide.

1.6 Research Questions and Objectives

The research is based on the questions (RQ) below, which serve as a guiding core during the research process.

RQ1. How is open-source adoption currently regulated? To understand a practical approach the chosen governments have taken to regulate and legislate the adoption and usage of open-source. To further answer and sustain the research questions, the following sub-research questions were formulated:

      SRQ1. What open-source legal frameworks are currently in place?

      SRQ2. What open-source adoption specifics are considered?

RQ2. How do governance considerations affect sustainable open-source adoption? To understand the relevance of governance guidance during the open-source journey concerning sustainable and effective adoption.

Research Goal: To analyze open-source adoption sustainability in the list of the chosen countries and propose governance recommendations for open-source software.

1.7 Research Design and Methodology

Once the author has formulated research questions and objectives, it was decided that a qualitative research method would be the most suitable approach to address the research goals above. The main criterion for selecting the qualitative research method was influenced by the fact that there was no room for experimentally manipulating the research objectives or aiming to measure the research objectives or outcomes in the format of numbers (Busetto *et al.*, 2020). Furthermore, the open-ended and exploratory research questions require a flexible approach to data collection and further synthesis. Therefore, using combined methods, including secondary data analysis, data comparison, and semi-structured one-on-one interviews, allowed the author to gather diverse and reliable ground to draw the required understanding and use the material further to expand the research arguments, comparisons and conclusions.

The first step, mirrored in *Chapter 2*, includes the analysis of secondary data and an academic literature review. This process involves collecting and reviewing pertinent information from academic and science databases, including peer-reviewed articles, governmental reports, research papers, and other publications. This step assists in determining the current state of OSS theories, practises and adoption tactics studied by a diverse list of authors covering legal and governance perspectives. Also, this analysis highlights the advantage of using OSS in the public sector and confirms the continuous presence of adoption challenges.

The second step presented in *Chapter 3* provides a case study covering the OSS regulatory set-up through 106 published policies within 8 data collection countries & supranational unions – India, Singapore, the EU, the UK, the US, Mexico, New Zealand and Canada. This thoroughly analyses how OSS is currently guided and regulated in the public sector. Moreover, the case study provides various overviews concerning the strategies, processes and formats used by public sector organizations implementing OSS as part of their digital transformation strategy.

The third step in *Chapter 4* involves a set of 5 semi-structured interviews with digital government and OSS experts. The interviews were transcribed *verbatim* without annotations for behaviour and phonetic transcription of dialects and filler words (Busetto *et al*., 2020). The gathered first-hand information from industry professionals validates the secondary findings from the abovementioned chapters. In addition, it provides valuable insights concerning governance considerations, compliance processes, operational changes, implementation challenges, intellectual property, adoption success metrics and collaboration engagement.

2. Literature Review

2.1 OSS Theories

The reviewed academic literature has used grounded, conventional, learning, process, actor-network and social network theories to achieve the necessary explanation to meet the research objectives. Furthermore, mechanism-based theory seeks to explain how and why a process with specific inputs can produce outcomes. For example, the DBO theory (Desires, Beliefs and Opportunities) explains actions analysis and interactions of individuals.

In the frame of this research, the author has focused on the grounded theory as a strategy for qualitative research (Williams & Moser, 2019), initially introduced by Glaser and Strauss to propose a theory based on the researched data inductively (Strauss, 1998; Stol *et al.,* 2016). This has allowed to sensitize available concepts and general perspectives, compare enforced OSS regulations in the chosen data collection countries and adopt initial concepts through sample OSS regulation based on the findings. It is known for grounded theory (GT) to have multiple streams, whereas three of the most known ones are classic Glaser's GT, Straussian GT and Charmaz's constructivist GT (Stol *et al.,* 2016). Glaser's classic GT stream proposes to question, "What do we have here?" while being focused on the data (*Ibid.*) and in the frame of this specific research, due to an intense incline towards continuous data comparison, the classic stream is the most suitable one. Also, the theory suggests delaying the thorough literature review to avoid the influence of previously published concepts (*Ibid.*). The initial information has been collected from "live" data from GovStack's expertise and document packages, confirming the reliability of choice above. The objectivism of the proposed research has derived from the data with a "tool" to describe reality (*Ibid.*).

In order to support the GT research even more stronger, the author has used Zachman's IS architecture framework to have a closer understanding of OSS adoption paradigms. The Zachman framework suggests focusing on the primitives to establish the answers to Who, What, When, Where, Why and How questions (Zachman, 2003). The complete answers to these six questions will derive any other potential information covering the same subject and form the base for the other subject's complete description. The author

has followed this framework throughout the research, specifically focusing on the six-question approach during the data collection countries' regulatory set-up review part.

2.2 OSS Adoption

The adoption of OSS in the public sector has been rapid throughout recent years, motivated by cost-efficiency, flexibility and strong innovation potential. However, to benefit from the mentioned environmental setting, public sector officials should consider the high probability of potential challenges, which must be evaluated before the implementation phase.

A thorough literature review confirms the lack of governance around OSS adoption and escalates recurring challenges around licensing issues and intellectual property protection (Kogut & Metiu, 2001; Vasudeva, 2012). The authors raise the importance of establishing internal policies and procedures and the need for constant engagement with the OSS community. The organizations are suggested to carefully consider all license implications before the adoption phase and ensure compliance programs and constant monitoring of changes in the legal landscape during the whole software life cycle (Vasudeva, 2012).

Also, Kogut & Metiu (2001) argue that due to OSS distributed environment, the production model of OSS is much more efficient than in-house hierarchical models. Furthermore, following the same argument, distributed environment enhances the probability for developing countries to participate in frontier innovation. The momentum from the developers' community combined efforts is believed to give quality to surpass proprietary counterparts (Reshad *et al*., 2020). The authors introduce OSS as a credible alternative concerning small and medium enterprises' limited funds. On the other hand, a multicultural open-source environment can affect better software outcomes due to the human capacity involved in the debugging and development process.

The importance of in-house solid legal function was brought up in the studies by von Hippel and von Krogh (2003), Suzor *et al.,* (2007), Gangadharan *et al*., (2012) and Franch *et al.,* (2013). The strong legal in-house function ensures proper management of legal risks, which should eliminate the probability of potential litigation and licensing issues. The authors recommend engaging legal functions early in the adoption phase to develop

compliance management strategies and risk assessment processes. Moreover, they recommend engaging with the OSS community and establishing internal policies and procedures with their support. As a bare minimum, Franch *et al.,* (2013) suggest addressing potential risks using a risk management framework which consists of four crucial components: risk identification, risk assessment, risk response planning, and risk monitoring and control. Gangadharan *et al.,* (2012) examined the challenges of OSS license management in the context of large-scale organizations and, based on the findings, recommended to implement license management tools and best practices to improve compliance and reduce legal risks since the organizations often lack the required tools and processes for effective management. Suzor *et al.,* (2007) researched three critical legal issues: intellectual property, liability, and procurement, and suggested that governments should be aware of the licensing terms, potential risks and procurement, which must fully comply with procurement laws and policies.

Another study by (Frost *et al.,* 2005) researched the complexity of OSS legal frameworks in the United States and Europe. As a natural consequence, complexity and variety in broad terms of requirements and restrictions derive the need for clarity that deters public sector organizations from OSS adoption. Therefore, the authors recommend simplifying and standardizing the approach for legal frameworks to address this issue to make the adoption process more accessible and straightforward.

Furthermore, an alternative approach to software development is another critical area of legal and governance readiness (Alspaugh & Scacchi, 2013). The study demonstrates the importance of ongoing collaboration between developers, users, and stakeholders above a traditional requirements-gathering phase. The classical approach of requirements gathering upfront in the development phase leads to inflexible and outdated results. Instead, the authors propose an iterative and incremental approach involving an ongoing dialogue with all participating parties to refine and improve the software throughout development. The article covers several case studies on software development, which successfully affirm the resilient potential of the suggested alternative approach.

Finally, the studies above highlight the importance of compliance program development, functioning license management tools, as well as a need for an accessible and straightforward legal framework and governance around OSS adoption subject matter.

Effective management of legal implications and the development of supportive guidance are critical to promoting the adoption and use of OSS by organizations and governments alike.

2.3 OSS in Practise

Above all, the author sought practical data to study real scenarios of OSS use in the public sector. Meanwhile, many countries are motivated to adopt OSS in order to reduce costs, Brazil has followed the strategic decision to diversify the selection of public services, products and new technologies using the assistance of collaborative knowledge and community environment (Paiva, 2009). Their projects use Java as a primary development platform, and electronic voting machines operate on GNU/Linux. Despite the prompt implementation of OSS covering most of the public sector's services on federal, state and municipal levels, the Brazilian government highlights users' resistance to change and the lack of local technical expertise in providing a Service Level Agreement (SLA). As importantly, the government suggests using a rational approach during the procurement process, having multiple alternatives open for consideration, including proprietary software. The decision is suggested to be based on the best return of investment solution (*Ibid.*).

The study by Zhussupova & Rahman (2011) researched the case study based on the Ministry of Oil and Gas of the Republic of Kazakhstan. As at the time of the study Kazakhstan was in its incipient level of OSS adoption in the public sector and the respective ministry has voiced its interest in migration to OSS, the authors have conducted interviews with ministry officials carrying out posts in IT management, procurement, administrative and organizational functioning. Also, the authors have distributed questionnaires to the internal staff as end-users to gather individual attitudes towards OSS adoption and change of end-user habits. The qualitative data has been distinguished into three adoption readiness levels: organizational, technical and individual. The research findings have determined that from the organizational perspective, the current IT strategy generally supports ICT working and implementation processes, however, lacks formulated policy towards OSS alternative procurement. At the moment of the IT strategy issue, the executive level did not consider any alternative software options to proprietary options to decrease the costs. The technical level would not affect migration to OSS as

the adoption process is expected to be executed throughout several stages divided into specific periods of time. Such a migration approach is expected to require less spending than a radical decision to switch to a new alternative. Personal perspective has pictured a strong interest and willingness (70%) to use OSS to perform daily responsibilities, however, has recorded a relatively low awareness level (63%) around the OSS subject in general, which could be enhanced with the support of training and guiding documents. The authors suggest including the OSS vision as part of the internal ICT strategy, which in this instance, would complement the general ICT vision of the organization. Ideally, adoption must be executed in a sequence of steps and monitored at every phase by the internal OSS team (*Ibid.*).

Furthermore, the study by Shaikh (2016) analyzes the process of OSS adoption by two different local councils in the UK, Camden Council and Bristol City Council. The author explores the adoption phase focusing on the negotiation processes between the public sector's stakeholders. The study highlights the necessity of negotiation awareness and understanding the political and cultural context in which the OSS procurement and adoption negotiations occur. Political context requires understanding the priorities and agendas of different stakeholders and the dynamics that exist within. The study found that IT and procurement specialists often have different priorities and avoid potential change, while senior management is more interested in cost savings and process efficiency. Cultural context requires a strong awareness of internal organizational culture and the wider social context in which they operate. Some stakeholders are noticed to have a stronger attachment to proprietary software, while others are more open to the values of collaboration within the OSS community and sharing that underpin. The abovementioned can be enhanced using various strategies such as building trust and relationships with stakeholders, developing a clear and compelling business case for OSS and demonstrating the bigger value of the approach through pilot projects or case studies (*Ibid.*).

The potential role of OSS in enabling the widespread adoption of blockchain-based e-government systems has been reviewed by Kassen (2021). In this regard, Estonia was one of the first countries to implement an open-source blockchain-based solution to manage its national health information databases for everyone. The project launched in 2016 aimed to protect the confidentiality and integrity of medical data at the national level (*Ibid.*). As per Jun (2018), blockchain-based government systems should rely on open-

source strategies. The disclosure reason is that it is necessary for everyone to verify compliance with the law embedded in the code as well as encourage the development of a community ecosystem to ensure software development and security (*Ibid.*).

The abovementioned studies have mostly examined the motivations for OSS adoption and the variables affecting its success or failure. According to studies, the main factors influencing the adoption of open-source software are cost savings, flexibility, and the capacity to tailor the program to meet particular in-house requirements. The studies have also noted difficulties such as a lack of local community assistance and knowledge, compatibility problems, and ongoing concerns about security and dependability.

3. Data Collection Countries

As per the literature review above, OSS adoption readiness has been evaluated chiefly based on technological, organizational and economic prerequisites. The research' author has focused on legal and governance prerequisites to propose sample guidance for public sector officials to follow further down the digital transformation implementation process. Based on the chosen data collection countries & supranational unions, which were India, Singapore, the EU, the UK, the US, Mexico, New Zealand and Canada, the author has researched the existent regulatory set-up, compared the OSS maturity levels, evaluated the most important factors for OSS general regulation and proposed the finalized research outcomes for the public sector's use.

Table 2. Data collection countries (Lostri *et al.*, 2022).

Data collection country	Open-source regulation/policy example	Nature of action	Total number of reviewed policies
India	Policy on Adoption of Open Source Software for the Government of India	Mandatory	12
Singapore	Digital Government Blueprint	Advisory	4
EU	Open Source Software Strategy 2020-2023	Advisory	16
UK	UK Government Licensing Framework, Open Software Licences; Open Standards Principles	Mandatory	10
US	Securing Open Source Software Act	Advisory and Mandatory	46
Mexico	Open Data Executive Decree	Advisory and Mandatory	9
New Zealand	NZGOAL Software Extension Policy	Advisory	1
Canada	Directive on Management of Information Technology, Annex C	Advisory and Mandatory	8

Each country regulates the usage and sharing of open-source software through different formats and regulation frameworks; some mandate it, and some publish it as a strong recommendation or guidance. Even though the format is different, each country similarly promotes their readiness regarding OSS public use and the open government model. As per Hardy (2010), "the interaction between industry regulation and OSS does not seem to have yet been investigated". During the OSS adoption, there is notably more focus on the required license other than the relevant ownership over OSS's patent (*Ibid.*). The word

"open" in open-source software continuously creates numerous misunderstandings regarding the legal owner behind this (*Ibid.*).

3.1 Regulation Approaches

The below analysis includes a diverse list of OSS regulations being issued either in the format of advisory or mandatory procurements, guidelines, digital agendas, national training programs, provisions or declarations of interest. Further down, the author refers to the abbreviation "policy" mentioned. Throughout the examination of 8 data collection countries and 106 reviewed policies, the findings have culminated in developing a thematic map to provide countries' main standpoints and OSS policy actions.
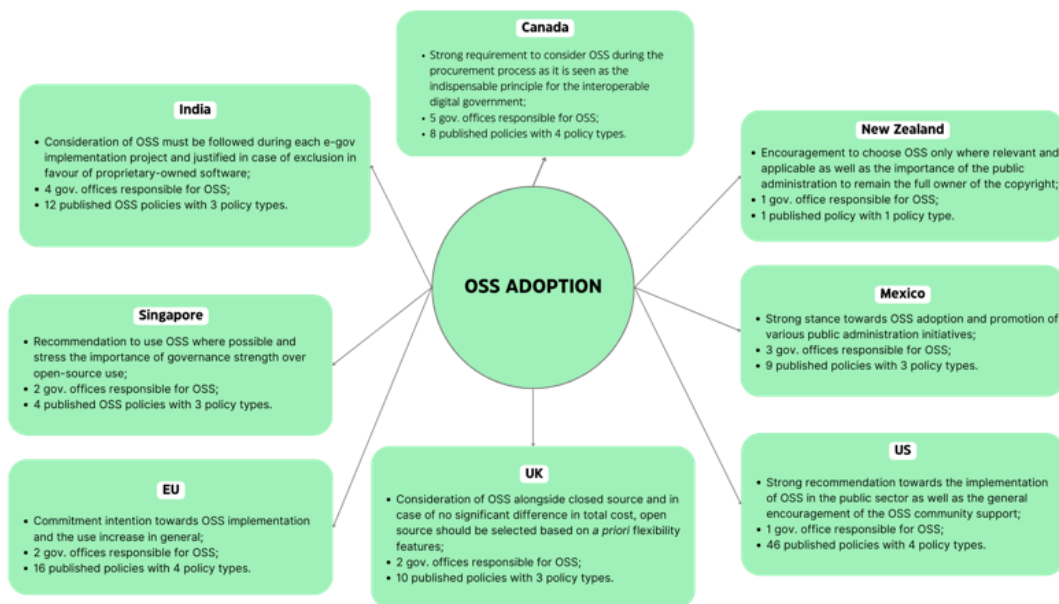

Figure 1. Data collection countries thematic map.

India

India has implemented a mandatory compliance approach in "Policy on Adoption of Open Source Software for Government of India" while targeting specifically three objectives:

- "To provide a policy framework for rapid and effective adoption of OSS."
- "To ensure strategic control in e-Governance applications and systems from a long-term perspective."

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- "To reduce the Total Cost of Ownership (TCO) of projects."

The consideration of OSS must be followed during each e-government implementation project and justified in case of exclusion in favour of proprietary-owned software (MCIT, 2014). India's president announced the intention to implement open-source for the first time in early 2003 (I2IT, 2003). Since then, there have been 12 crucial legislations to frame the current adoption of open-source on the scale of the public sector in India (Lostri *et al*., 2022).

As of today, the key policymakers responsible for any OSS implementation in the country are the Ministry of Electronics and Information Technology (MeitY), the Digital India Corporation (DIC), the National e-Governance Division (NeGD) and the IT in Emerging Areas Division (ITEA) (EC, Unit D2, 2021).

MeitY is responsible for all matters concerning the regulation of information technology agendas in the country, including the OSS policies reviewed within this research. DIC is a non-profit extension to MeitY focusing on innovation strategies and oversight support over issued policies by the latter one. NeGD is a division under DIC providing technical support and project management services on digital transformation undertakings by the country's public administration offices. ITEA researches, develops and deploys FOSS solutions (*Ibid.*).

As per above, the use of OSS in India's public sector is effectively regulated by the backbone of multiple ministries and subdivisions, which objectively assists the thorough promotion of OSS use.
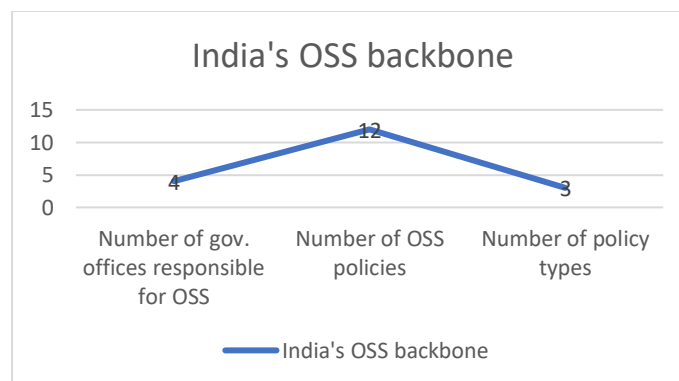

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Figure 2. India's OSS backbone.

Singapore

Singapore follows OSS enforcement's general advisory character through procurement announcements for open-source operating systems and general digital agendas such as "Digital Government Blueprint" (GovTech, 2020; Lostri *et al.*, 2022). The government recommends using OSS where possible and stresses the importance of governance strengthening over open-source use (*Ibid.*). Since the first procurement with a note preference regarding the open-source in 2003, Singapore has publicly campaigned for OSS on four governmental occasions in either a procurement-advisory contest or a "how to use" guidance document (Lostri *et al.*, 2022).

Singapore is an exemplary participant of the OSS community, validating that the earlier mentioned mandatory regulation format is not always necessary. Furthermore, the government has proved the transparent and rational standpoint regarding open-source implementation benefits, which first-hand affected the rate of the OSS inclusion in the public administration's solutions and technologies.
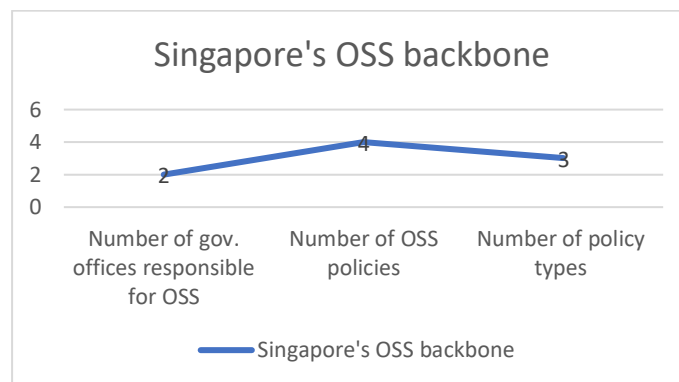

Figure 3. Singapore's OSS backbone.

EU

European Union (EU) has one of the most diverse and active political paths concerning open-source adoption. The prevalence of OSS-related policies and the timescale for political and legislative measures' endorsement demonstrates that OSS has taken on an increasingly significant role throughout Europe. The very first action towards the open-source agenda took place in 2001 via a resolution on network and information security

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(Lewis, 2010; Lostri *et al.*, 2022). Later in 2004, the European Commission proposed the "Resolution on the Promotion and Introduction of OSS", presenting it as a support for the eEurope 2005 Action Plan, which could help to re-align the programme's e-government objectives (EUR-Lex, 2003). However, the resolution needed more support and was not adopted (*Ibid.*). Besides that, eEurope 2005 Action Plan shall still be considered the main force behind open-source adoption in the EU as it was strongly encouraged by "Open source software strategy 2014-2017" and "Open source software strategy 2020-2023". Furthermore, the Commission has emphasized its commitment to OSS implementation and the use increase in general (EC, 2020; Lostri *et al.*, 2022).

Geographically, OSS is under the visible focus of legal and political measures in 18 of the 28 European nations (EC, Unit D2, 2020). Further, nine countries have addressed OSS as a component of a larger political or legal digitalization initiative. However, only Cyprus and Ireland did not address OSS in their legal and policy frameworks (*Ibid.*).

In summary, the EU's support of OSS adoption has significantly increased. Furthermore, the extensive presence of policies addressing OSS and the timeline show that OSS progressively plays an actual appearance in Europe (EC, Unit D2, 2020).
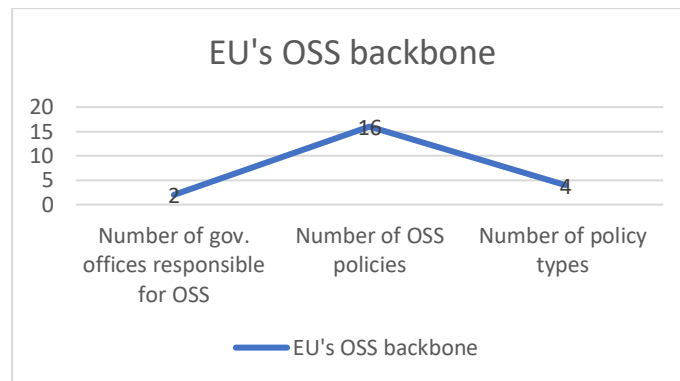

Figure 4. EU's OSS backbone.

UK

The United Kingdom's (UK) government has not been straightforward regarding the unified agenda covering open-source. In 2004, concerning the "Open Source Software: Use within UK Government. V. 2" strategy, the decision was to make software choices based on a money-for-value basis without direct open-source preference (e-Government

Unit, 2004; Lostri *et al.*, 2022). On the other hand, in 2005, the "Open Source, Open Standards and Reuse Government Action Plan" established the readiness to consider open-source solutions alongside closed source and in case of no significant difference in total cost, open-source should have been selected based on *a priori* flexibility features (CIOC, 2005; *Ibid.*). A decade later, the UK's government published a policy paper on open standards principles and has raised attention towards boosting the use of open-source by the country's public administrations (GovUK, 2013; *Ibid.*).

Various documents on OSS use have been published by the Cabinet Office of the UK Government's Digital Service unit, responsible for the overall deployment of digital platforms and leading digital, data and technology functions of the UK's public sector (EC, Unit D2, 2020). In addition, the Crown Commercial Service is an executive sub-agency under the previously mentioned body, which is responsible for the UK government's OSS "GOV.UK" policy (*Ibid.*).
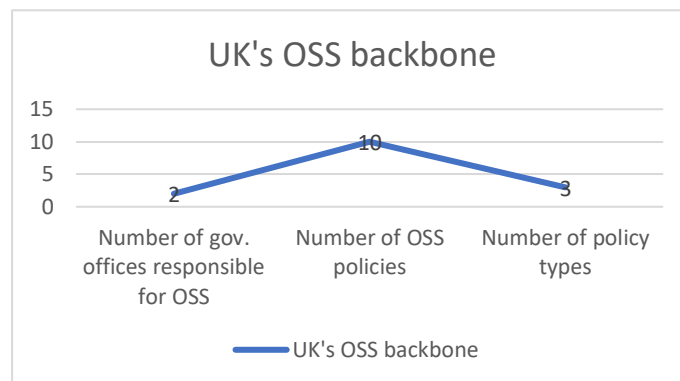

Figure 5. UK's OSS backbone.

US

The United States of America (US) was the apparent pioneer in regulating and promoting open-source concepts due to the local development of key OSS projects such as Stallman's GNU project and Linux kernel. Since 2000, the government has strongly recommended implementing open-source in the public sector and the general encouragement of OSS community support (Lostri *et al.*, 2022). Since the first mentioned report, the US has publicly campaigned for using OSS 46 times through either an advisory or a mandatory legislative document (*Ibid.*).

The above uptake of OSS implementation in the US stands behind the General Services Administration (GSA) (EC, Unit D2, 2021a). The GSA is in charge of federal procurements with the application agenda of the principle "OSS-first "as well as numerous OSS initiatives such as "Cloud.gov[2]", "Code.gov[3]", "Data.gov[4]", etc. (*Ibid*.).
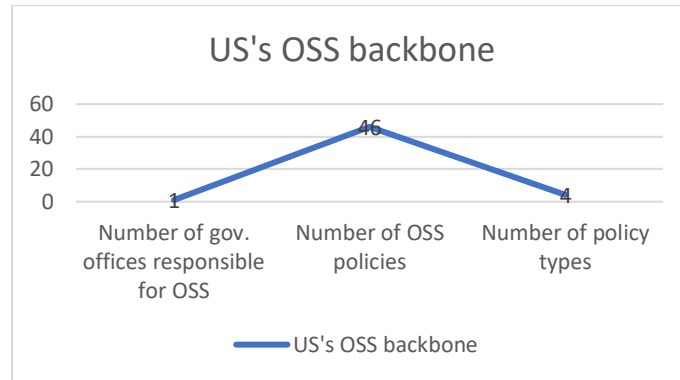

Figure 6. US's OSS backbone.

Mexico

In the case of Mexico, OSS was introduced in 2001 with a considerably radical approach which would have mandated the use of OSS on all governmental computers via the proposed directive "Mandatory OSS on government computers" (Baker *et al*., 2009; Lostri *et al*., 2022). However, the legislative bill mandating the preferential use of OSS was approved only 18 years later, in November 2019 (CDLU, 2019). The government has been prompted by the "Republican Austerity Federal Law" law to promote their preference over OSS concerning mandated federal cost-saving efforts. Furthermore, in 2021, OSS was announced as the key objective of the "Planning Process for the Development of the National Digital Strategy and Technology Policy", which seeks digital autonomy, sovereignty and independence by prioritizing free software and open standards (Lostri *et al*., 2022).

In conclusion, Mexico supports using open-source software and has been striving to promote its use in numerous areas. The government has established the Free Software Act, including the Mexican Association for Free Software in the list of organizations

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[2] https://cloud.gov/?dg
[3] https://code.gov/?dg
[4] https://data.gov/?dg

authorized to receive a subsidy under the Program for the Development of the Software, launched programs to encourage the use of OSS, and has utilized OSS in numerous projects aimed at enhancing public administration (*Ibid.*).

Figure 7. Mexico's OSS backbone.

New Zealand

New Zealand did not mandate the use of open-source as of 2023 and has only issued the strategic framework "NZGOAL" in 2014, which encourages choosing open-source in case the public administration is the complete copyright owner (NZ Gov, 2017). The New Zealand government has stressed the lack of intention to participate in the debate of open-source versus closed-source and use the benefits of OSS only where it is relevant and applicable (*Ibid.*).

In summary, New Zealand has been relatively discreet towards OSS adoption trends, however, it promotes adoption readiness in public sector initiatives where such a software approach is entirely relevant and justified.

Figure 8. New Zealand's OSS backbone.

Canada

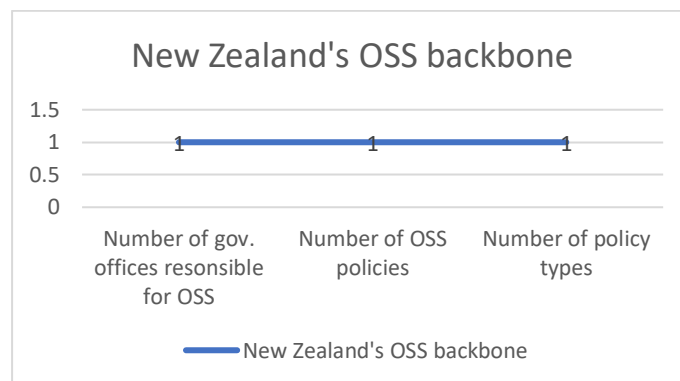Canada formed its first statement around OSS in 2006, later replacing it with the "Strategic Plan for Information Management and Information Technology 2017 to 2021" (TS of CS, 2020). The strategic plan has included a strong requirement to consider OSS solutions during the procurement process and was seen as the essential principle for the interoperable digital government (*Ibid.*). Furthermore, in 2008, the government issued a guiding digital standards playbook which listed open-source as the leveraging principle of the government's digital enhancement (TS of CS, 2021).

The regulatory process of Canada involves multiple layers, including federal, provincial, regional and city and hence requires the promotion of OSS on each of these layers (EC, Unit D2, 2021b). The main stakeholders in the OSS development in the country are the Government of Canada, the Minister of Digital Government, Shared Services Canada, the Treasury Board of Canada Secretariat and Canadian Digital Service (*Ibid*.).

Figure 9. Canada's OSS backbone.

The analysis of the regulatory position of OSS in the governments of India, Singapore, the EU, the UK, the US, Mexico, New Zealand, and Canada demonstrates the growing significance of OSS in public sector organizations. These mentioned governments have enacted policies that encourage the use of OSS in several ways, including donating open service codes to the public and promoting OSS use in public service procurements. The countries studied in this review have made notable strides toward embracing and implementing OSS in their public sector organizations. However, there are still obstacles to overcome, such as the need for clear frameworks, subject awareness and increased cooperation between governmental organizations and the open-source community.

4. Research Findings and Analysis

The idea of open-source in digital governance has drawn much attention recently as a way to enhance public services and boost digital sovereignty. Given the growing acceptance of open-source functionality in the public sector, it is crucial to comprehend the viewpoints and experiences of digital government experts at the forefront of this transition. Therefore, five semi-structured interviews were performed with experts in digital government from Estonia, the US, France, India, and Switzerland to examine these points of view and corroborate previous findings. Microsoft Teams was used to conduct these interviews, which were then transcribed for additional examination. NVivo software assisted in rectifying the interview data and conducting an analysis that revealed significant categories and trends in the experts' arguments and input. The experts chosen for this study were picked based on their breadth of expertise and experience in open-source adoption and digital government. They come from different corners of the world and have experience in various positions in the public sector and the open-source community, such as those held by politicians, decision-makers, IT advisors and experts.

Through these interviews, the experts were able to share their knowledge and experiences about open-source adoption in the public sector, including the governance issues and new opportunities that come along with it. The researcher has chosen to protect the anonymity of the interviewees in order to encourage a more frank and open discussion. The author aimed to provide a safe and secure environment where interviewees could discuss their ideas, challenges, and experiences without fear of retaliation or adverse effects by maintaining the confidentiality of the respondents. This method also ensured that the study's emphasis stayed on the research objectives and difficulties associated with the OSS adoption in the public sector rather than on the study's interviewees. Using this method, the interviews gave the author a more thorough overview of the open-source adoption status in digital government and the opportunities and difficulties that still need to be overcome.

Table 3. Interview data.

Interviewee's code	Interviewee's Current Position	Interview Format	Date
Interviewee A	President of Global Open Source Project	Teams Recording	29.03.2023
Interviewee B	Digital Government Regional Coordinator	Teams Recording	28.03.2023
Interviewee C	Identity Solutions Expert, Civil Identity System Product Manager	Teams Recording	30.03.2023
Interviewee D	Digital Services Senior Coordinator	Teams Recording	23.03.2023
Interviewee E	Interoperability Governance Expert, Programme Manager of Technology	Teams Recording	29.03.2023

Following the above interviews, the data was further analyzed and classified into seven open-source adoption subtopics. The analysis of seven subcategories resulted in creation of a thematic map that serves as a guide for the fundamental suggestions and factors to be considered while adopting open-source software.

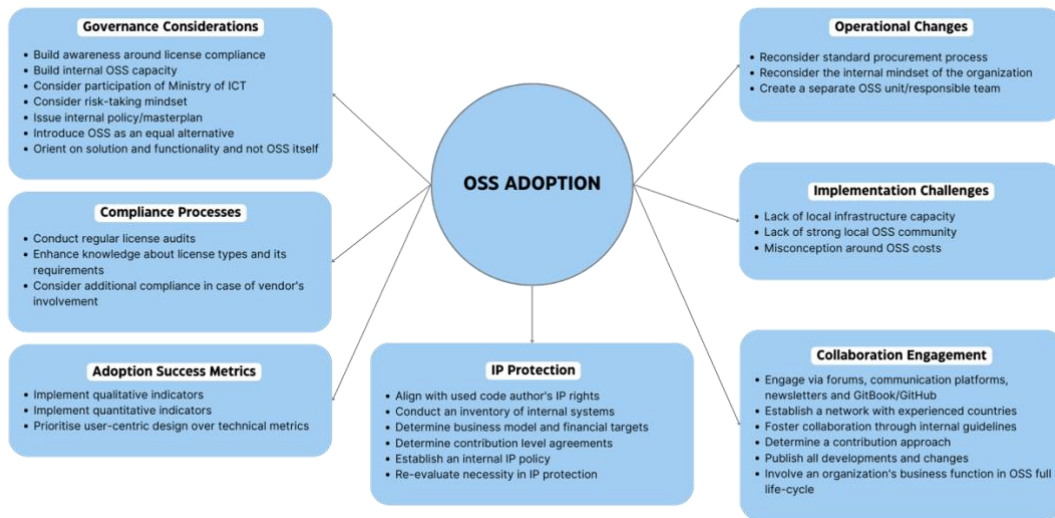Figure 10. Interview findings thematic map.

4.1 Governance Considerations

Throughout the discussions, the interviewees brought up various governance considerations that must be acknowledged before adopting open-source. The critical element to the successful and operational open-source project was brought up by Interviewee E, stating that *"Open-source itself should not be a consideration, but a viable*

option and strong alternative to other available solutions on the software market. The government should not be open-source-oriented, but instead be oriented on the public service and what kind of functions it requires from the technology. This is what should drive and define the initial definition of the procurement." Before committing to an open-source code and ensuring that the selected license type and intellectual property protection align with the organization's internal legal framework, it is essential to comprehend the specifics of the chosen approach for bringing the desired implementational change. It is recommended that governments should first *"..put all different possibilities and options on an equal footing and make an objective choice based on if it is going to respond to the current organization's functionalities."* (Interviewee D).

Given the analysis's current state, "capacity building" and "internal competency" were mentioned 15 times. Four interviewees mentioned this aspect's vital importance throughout the open-source life cycle. For example, interviewee C states, *"The first thing of open-source governance is capacity building; if you do not have any, you will have no chance to govern nor operate it."* One of the main benefits of internal competency and capacity building is that it enables governments to reduce their reliance on external vendors for support and maintenance of open-source systems. Instead, government employees can take on more significant roles in developing and implementing open-source solutions, which helps save costs and ensure open-source sustainability. Moreover, it helps to promote internal innovation and ensures that open-source systems are developed and managed in compliance with legal requirements and security protocols. If it succeeds, *"..governments can inspire much internal innovation which can be sourced from openly available codes or the community."* (Interviewee B).

Interviewee A has raised the importance of fully understanding license criteria in the format of a strong, available legal function with a resource to support the adherence correctly. It can ensure compliance with licensing requirements, mitigate legal risks, protect intellectual property, negotiate favourable contracts, and enable collaboration with the community. Public sector organizations can reap the benefits of open-source software by working closely with legal professionals while managing legal risks effectively (Ali, 2023).

The need for an internal policy or masterplan was raised twelve times, and the interviewees made it quite clear that "*If you are engaged in an open-source community, and you would like to adopt open-source, you have to have a clear policy on how you are going to maintain it."* (Interviewee D). Adopting open-source software comes with challenges like legal compliance, security risks, and maintenance issues. These challenges can be mitigated by having a clear policy or master plan that outlines the organization's strategy for managing open-source software. With a clear policy or master plan, organizations may be able to maintain open-source software, including the risk of security breaches or non-compliance with licensing requirements. This is critical because open-source software requires ongoing maintenance, including updates, bug fixes, and security patches, to ensure its continued reliability and functionality. A clear policy on maintaining open-source software can help organizations plan and budget for these activities, ensuring the software remains secure and up-to-date.

Consequently, from the political perspective, Interviewee C has experienced good practice with countries with a strong local Ministry of ICT. It was noted that in scenarios where a ministry has enough of a mandate to deliver the proper governance, it enhances the chance for much more active participation, which results in proper open-source community support in the country.

Finally, the interviewees mentioned the importance of a government's mindset change. Interviewee A has experienced *"..reluctance and hesitation from the public sector to contribute to open-source software",* and Interviewee B has mentioned the constant state of *"The risk-averse attitude towards adopting anything new"*. Also adding that *"We could incentivize risk-taking within the government. That would change many things, for example, the appreciation for how technology can be created as open-source and yet be secure and private".* By incentivizing risk-taking, organizations can encourage innovation and experimentation, leading to more effective and efficient solutions for citizens. Moreover, incentivizing risk-taking can change the perception of open-source software within the public sector. By recognizing the benefits of open-source software and promoting its adoption, public sector organizations can create a more innovative and efficient ecosystem that benefits both the government and its citizens.

4.2 Compliance Processes

The main problem mentioned in each interview was low awareness about open-source licenses and published conditions. This level of awareness frequently has legal repercussions, such as litigation, penalties, and reputational harm. Additionally, a lack of understanding of open-source licenses may result in problems with internal stakeholders or outside vendors. For instance, if various divisions interpret open-source licensing differently, this may cause confusion and inefficiency. Similarly, if public sector organizations partner with external organizations or contractors with different expectations or interpretations of open-source licenses, this can lead to disagreements or even legal disputes. Interviewee E has suggested implementing regular license audits as a potential solution to such risk. By conducting these regularly, public sector organizations can stay up-to-date with their software licenses and avoid negative consequences related to non-compliance or misuse of open-source software. Also, this can help close the knowledge gap and ensure that employees know the legal obligations associated with using open-source software.

As an additional layer during the new software deployment process, as per Interviewee C, a system integrator will often need to manage the installation and customization. In order to eliminate potential non-compliance scenarios during this phase, "*There must be a contract with an outsourced integrator to ensure the compliance with the initial license, so there will be no risk to lock-in yourself in their independent version of the initial software. It will be much easier to have freedom once the integrator considers the default open-source code*". Therefore, there is a strong need to plan and think about correct software maintenance even once specific stakeholders have completed their input.

Public sector organizations that use open-source software need to invest in open-source licensing awareness and treat compliance role in their process as a crucial first step. While limiting risks and unfavourable effects, it can assist the organization in ensuring that employees are informed, everyone has a unified line of understanding, the company is compliant with regulatory obligations, and the benefits of open-source software are fully realized.

4.3 Operational Changes

One of the critical operational changes required when adopting open-source software in the public sector is a shift in mindset. Interviewee B has experienced in practice that *"There is a certain amount of apprehension that government stakeholders bring to the table whenever there is a conversation around open-source adoption. It is the lack of appreciation for what open-source can do"*. Traditionally, government agencies have relied on proprietary software that is often expensive and inflexible. On the other hand, open-source software is typically much more cost-efficient and can be modified and customized to meet the agency's specific needs. This requires changing how government officials think about software procurement and development and a willingness to embrace new technological approaches.

Another operational change required when adopting open-source software in the public sector is rethinking the procurement process (Interviewees A, B, D). Traditionally, government agencies have relied on complex procurement processes that often favour proprietary software vendors. This can make it difficult for open-source vendors to compete. To address this, government agencies must develop equal procurement policies open to open-source solutions and prioritize functionality and value over brand recognition.

Interviewee B has raised the effectiveness of having a separate unit fully responsible for open-source governance. Interviewee D has confirmed the intention to establish such a unit in the interviewee's public sector organization. The stakeholders acknowledge the importance of such restructuring, which is expected to bring more resource capacity towards this subject's development. The practical experience of Interviewee B has illustrated that the government which earlier took the suggested approach succeeded *"..to create strong governance over this topic and that is how exactly they have addressed the challenge of adoption of open-source within the government"*. The respective team was responsible for correct open-source implementation and introducing open government alternatives across the government's organizations and ministries. Overall, such a unit can be alternatively responsible for identifying and evaluating open-source solutions, integrating open-source software with existing systems, managing licenses, and providing user support. Moreover, another benefit of having a dedicated unit for open-source

deployment is that it can promote collaboration and knowledge sharing within the organization and open-source community.

4.4 Implementation Challenges

The ability of the local infrastructure to support the deployment and operation of information technology systems is essential, especially in areas with a shortage of qualified IT personnel. The significance of this issue is highlighted by the findings of the interview discussions with Interviewees B, C, D, and E since the subject was brought up 14 times throughout the interviews. Prominent proprietary vendors in some locations, such as the Balkans, can significantly affect the availability of technical skill sets in the local market. This may lead to a shortage of skilled workers with the necessary skills to support occupations such as Linux System or PostgreSQL administrators. This problem is made more significant by lacking a strong local IT professional community, as businesses may find it challenging to find and recruit suitable applicants for technical positions.

Organizations operating in areas with low local infrastructure capability must therefore develop solutions to this problem. Creating alliances with other organizations that offer technological know-how and support locally or remotely is an achievable strategy. Developing regional talent and creating a pipeline of qualified IT experts within the area can also be accomplished by investing in training programs.

Another issue that results from the low local infrastructure capacity in some places is the absence of a strong local open-source community, in addition to the effect it has on the availability of technical skill sets. As was mentioned in the interviews, there is frequent reluctance among governments to adopt open-source solutions since it is believed that there will not be any essential support once the software is implemented and that there is no guarantee that the system will perform on a bigger scale. This impression can be ascribed to ignorance and lack of awareness. Additionally, open-source software frequently benefits from a larger pool of knowledge and support resources than is typically offered by proprietary software because it is developed and maintained by a global community of contributors.

The misconception that open-source software is entirely free and without costs is an obstacle that businesses and government agencies thinking about adopting it frequently confront. As mentioned in the interviews, stakeholders need to know the actual costs involved with implementing, expanding, hosting, and maintaining open-source software. Although open-source software can usually be downloaded and used for free, there are typically extra fees involved in its deployment and continuing maintenance.

4.5 Intellectual Property Protection

Despite intellectual property (IP) frequently referring to the private sector and commercial industries, the public sector is also starting to acknowledge the relevance of IP. This is especially true regarding open-source software, which presents particular difficulties and prospects for IP protection. Open-source software is often distributed under licenses that, subject to a few restrictions, allow users to use, modify, and distribute the software freely. In order to fully capitalize on the benefits of open-source adoption while reducing potential liabilities, public sector organizations must manage challenging legal and technical concerns relating to IP protection.

Interviewee A states that the risk of internal IP being unintentionally included in an open-source code project must be reduced. This risk must be mitigated by determining whether a contribution will be held under an individual contributor or corporate-level agreement. This can be done by creating standards for choosing and using open-source software, managing open-source license and compliance processes, and methods for giving back to the open-source community. An inventory of internal systems must also be conducted to avoid unintentionally incorporating internal IP into open-source work. Moreover, it is crucial to ensure compliance with the IP rights of their producers while using public individual libraries and components.

Interviewees A, C, D, and E regularly suggested that IP should not apply to open-source initiatives in the public sector. Interviewee E specifically emphasized that in such circumstances, governments should not try to protect their intellectual property because their work serves the public benefit and is not motivated by financial interests in any particular industry. The interviewee further noted that, at least in the case of Estonia,

government authorities have not monitored IP's further usage or prevented vendors from reusing solutions in other procurements.

4.6 Adoption Success Metrics

Depending on the goals and priorities of the organization, open-source adoption success measures might vary, but they often comprise both quantitative and qualitative indications (Interviewees B, D). Quantitative metrics may include indicators like the proportion of software development projects that use open-source software, the number of open-source components or projects integrated into the organization's systems, and the cost savings from switching from proprietary to open-source software. Improvements in software quality and dependability, better teamwork and creativity among software development teams, and increased adaptability and flexibility of software systems are a few examples of qualitative metrics.

Interviewee B states, *"Tech teams tend to measure success in the format of metrics, which may not always necessarily lead to the intended outcomes. This must be addressed using user-centric design and allowing metrics to flow in from such processes"*. The viewpoint of interviewee B on the drawbacks of using metrics to gauge acceptance of open-source is consistent with broader criticisms of the specific, output-based metrics frequently used in modern technology development. The effectiveness of open-source adoption can be usefully understood through quantitative measurements. However, these metrics may need to include the more complex elements of user involvement and experience, such as usability, satisfaction, and community collaboration. This strategy is consistent with the participatory design and human-centred design tenets, which aim to ensure that technological solutions are adapted to the needs and contexts of their users and that user viewpoints are taken into account throughout the development process. Organizations can better connect their open-source adoption strategies with the requirements and preferences of their stakeholders and generate more meaningful and lasting outcomes by prioritizing user-centric design over metrics-driven approaches.

4.7 Collaboration Engagement

Effective collaboration involvement is necessary for the public sector to embrace OSS successfully. Organizations must create explicit policies to encourage community and

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contribution because these elements are essential to the OSS philosophy. Interviewee A stresses the significance of including business analysts, managers, and personnel in charge of user-end versions in the initial phase of collaboration and development to fully understand the value of the open-source and contribute to it. Interviewee D recommends establishing an internal open-source division to engage in the relevant communities, streamline open-source knowledge, and guarantee internal and external usage consistency. Interviewee C suggests that in order to foster collaboration, new OSS adopters should connect with established nations facing comparable difficulties. Interviewee B also suggests involving students with liberal arts backgrounds to contribute various business ideas and viewpoints. This would guarantee that various value systems are represented in technology encoding. All interviewees agree that various networking forums, communication tools, round tables, newsletters, and capturing internal developments and conversations on GitBook/GitHub are essential to increase collaboration involvement.

Both the public and private sectors must contribute to OSS development in order for it to continue and expand. Joining open-source communities gives you access to a vast network of programmers, testers, and users who can provide assistance and feedback. This may speed up the creation and enhancement of open-source software, enhancing its dependability and utility in the public sector.

5. Discussion

This study utilized a qualitative method with combined approach to address the research questions. The first phase needed to examine secondary data and academic literature to thoroughly understand the chosen topic and its current issues. Additionally, this phase contributed to identifying common strategies used by the public sector globally and evaluating the regulatory setting for open-source adoption across eight data collection countries. Finally, this data gave a solid foundation for answering the first research question, which explored the regulations that are currently established regarding the utilization of open-source software:

RQ1. How is open-source adoption currently regulated?

    SRQ1. What open-source legal frameworks are currently in place?

    SRQ2. What open-source adoption specifics are considered?

H. According to the hypothesis for the study above questions, each country regulates the use and distribution of open-source software using a different regulatory framework and format. Some countries enforce its use through legislation, while others only publicize it as strong recommendations or guidance. Based on the 106 policies examined, the published documents typically include directives, digital agendas, national training programs, provisions or declarations of interest, and advisory or mandatory procurement. The findings indicate that seven out of the eight countries involved in the data collection strongly support giving open-source software an equal footing during procurement. In contrast, one country supports using it only when feasible and relevant. The study concluded that the quantity and nature of published policies do not significantly influence the successful adoption rate but rather the general government's mindset toward the topic.

Five semi-structured interviews with digital professionals in the public sector were conducted as part of the second phase of the research process. This step was intended to validate the analysis using the selected case studies and secondary data from the first phase. The researcher obtained first-hand insights from the interviews regarding public sector professionals' difficulties while implementing open-source solutions, the advantages of employing open-source software, and the methods used to address potential difficulties. In addition, the exchange of ideas and collaborative contributions from

professionals in the field facilitated the development of a response to the second research question:

RQ2. How do governance considerations affect sustainable open-source adoption?

H. Open-source software adoption is substantially impacted by successfully applying strong governance principles. Thirty-one crucial factors that must be considered during the preliminary stages of a potential adoption project have been discovered by the author after they have been synthesized under seven subcategories of pertinent information. In this context, governance refers to the rules, practices, and frameworks that support the efficient and long-lasting operation of the open-source organization or community. Critical governance assessments that affect long-term open-source adoption include the following subcategories: governance considerations, compliance processes, operational changes, implementation challenges, intellectual property, adoption success metrics, and collaboration engagement.

Considering the research goal, it is evident that the study has achieved its intended purpose. The goal provided a precise and succinct articulation of the research objectives and laid the study's foundation. Furthermore, the goal established the study's course by outlining the major research topics, assuring an organized and deliberate approach to the assessment of governance procedures and the sustainability of open-source adoption in the chosen countries, namely:

RG. To analyze open-source adoption sustainability in the list of the chosen countries and propose governance recommendations for open-source software.

H. The study examined the viability of open-source adoption in the chosen countries and offered valuable recommendations for open-source software governance practices. The study used a thorough methodology that identified key governance factors that affect the adoption of open-source software sustainably while also considering the distinctive settings of the countries selected for data gathering. The recommendations presented in the study are based on sound empirical evidence and offer public sector professionals numerous insights that can guide their future project planning and implementation efforts. As such, it can be concluded that the research goal has been fully met.

The study findings support the analyzed literature review through practical data collection case studies and semi-structured interviews with diverse industry experts and add the

body to the topic knowledge. The continuous rise of license awareness and IP challenges was initially cited from the research of (Kogut & Metiu, 2001; Vasudeva, 2012), lack of legal expertise (Reshad *et al*., 2020) and tool for OSS license management (Gangadharan *et al*., 2012) were confirmed throughout interviews with experts which had an opportunity to share recent experience and inputs from the international projects they are currently part of. Consequently, the chosen time span (23 years) of picked literature review materials and identified challenges herein remain present.

5.1 Research Limitations

While the qualitative research method employed in this study effectively provides a comprehensive examination of open-source adoption sustainability, it is essential to acknowledge the potential limitations of this research methodology. One limitation is that the countries chosen for the case study's data collection may need to indicate the regulatory frameworks in other countries embracing OSS fully. As a result, the conclusions might be limited and not apply to situations other than those in the reviewed examples. Another limitation is that using semi-structured interviews may lead to bias due to the interviewer's questioning style or the interview context. Additionally, the number of interviews needs to be more significant to reflect the entire industry, potentially resulting in biases in the data. Finally, using academic papers as a data source may result in a need for more completeness in the findings. Academic papers and their issue date may not always provide a complete picture of the same research perspective of the open-source adoption projects examined.

Despite these possible limitations, the combined methodology used in this study offers a thorough evaluation of the sustainability of open-source adoption, revealing fundamental legal and governance principles that impact sustainable OSS adoption. The study contributes to the ongoing maturity process of open-source adoption sustainability by identifying possible challenges and provides the foundation for further research.

5.2 Prospects of the Future Work

Since the subject is relatively immature in the public sector, numerous vectors are yet to be researched. The author suggests choosing a practical setting. Hence, the future research prospects could involve a stakeholder in the form of a public sector office intending OSS

adoption, which could offer ongoing governance data regarding a process, challenges, newly faced obstacles and how-to strategies to overcome these. The potential research format could be conducted as an evaluation, assessment or case study comparison. Furthermore, future work could include the analysis of stakeholder engagement strategies, the long-term sustainability and maintenance considerations, or exploring methods for measuring the performance and impact of OSS in the public sector. Finally, the research scope could involve the legal and regulatory issues associated with OSS adoption in the public sector.

6. Conclusion

The research in the frame of this thesis was a holistic effort to study the open-source software adoption concept present in the public sector and analyze the adoption from legal and governance perspectives. The author set a target to source a diverse regulatory sample set of data based on 8 data collection countries, resulting in the study of 106 official policies. This phase allowed for synthesizing the connection between the nature and quantity of policies against the sustainability and success of actual OSS full adoption in the public sector of the respective country. The findings revealed that the nature nor amount of published policies do not significantly affect the successful adoption rate. The actual driver behind the adoption force is the innovative mindset in the government, the subject awareness, and the readiness to move forward from vendor lock-in software. This was consequently confirmed during the second phase of the research throughout the interviewing process with digital government and OSS experts. Based on the analysis, the author had an opportunity to code experts' input into seven main subcategories with 31 critical governance assessment criteria, which subsequently should impact sustainable OSS adoption in the public sector and awareness about the subject in general. Relatedly, the research findings should decrease the uncertainty gap in the lack of legal and governance guidance and provide public sector officials with practical recommendations. As a result, they will have the chance to use these research findings to guide their project planning and decision-making, resulting in a more efficient and sustainable adoption of OSS. Using this study, the public sector may ensure that its initiatives follow accepted governance principles, reduce the risk of potential challenges, and ultimately accomplish its digitalization objectives.

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Appendix 1. Non-Exclusive Licence

I, Alika Vandtke

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Appendix 2. Interview Questions from an Internal Perspective

1. What are the governance/policy considerations that an organization must take into account when adopting open-source software?

2. What processes do you have to ensure that your organization complies with open-source licenses and meets its obligations?

3. Did your organization require any policy or procedure changes to accommodate open-source software adoption? If so, what were these changes?

4. How do you balance the benefits of open-source software, such as cost savings and community support, against the potential challenges of integrating and maintaining those projects in your technology stack?

5. What challenges have you encountered when adopting open-source software, and how have you addressed those challenges?

6. What steps did your organization take to protect its intellectual property when contributing to open-source projects?

7. How do you measure the success of your open-source software adoption efforts, and what metrics do you use to evaluate the impact of those projects on your organization?

8. How do you engage with other organizations using open-source software, and what benefits do you gain from those collaborations?

9. What strategies have you implemented to foster collaboration and communication between your organization and the open-source communities whose projects you use?

10. What advice would you give to other public sector organizations to ensure governance readiness for open-source software adoption?

Appendix 3. Interview Questions from an External Perspective

1. What governance considerations must an organization consider when adopting open-source software?

2. What processes must be in place to ensure compliance with open-source licenses?

3. Did you oversee changes to established policies or procedures to accommodate open-source software adoption? If so, what were these changes?

4. What challenges have you witnessed during open-source adoption, and how have these been addressed?

5. What steps do organizations usually take to protect their intellectual property when contributing to open-source projects?

6. What strategies can be implemented to foster collaboration and communication between an organization and the open-source communities?

7. What advice would you give to other public sector organizations to ensure governance readiness for open-source software adoption?