TALLINN UNIVERSITY OF TECHNOLOGY
School of Information Technologies

Tairi Pallas 232646IVGM

# Implementing large-scale information systems of the European Union: the Estonian case of the Entry/Exit and the European Travel Identification and Authorisation Systems

Master's thesis

Supervisor: Silvia Lips
PhD

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TALLINNA TEHNIKAÜLIKOOL
Infotehnoloogia teaduskond

Tairi Pallas 232646IVGM

# Euroopa Liidu suurte infosüsteemide rakendamine: riiki sisenemise ja riigist lahkumise ning Euroopa reisiinfo ja -lubade süsteemide juhtum Eesti näitel

Magistritöö

Juhendaja: Silvia Lips
Phd

Tallinn 2025

# 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. This thesis has not been presented for examination anywhere else.

Author: Tairi Pallas

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# Abstract

This master's thesis investigates the implementation of large-scale information systems within the European Union (EU), focusing on the Estonian case of the Entry/Exit System (EES) and the European Travel Information and Authorisation System (ETIAS). The study employs a case study methodology and qualitative research principles to examine policy-related, legal, organisational, and technical challenges encountered during the development and implementation phases. The findings highlight different discrepancies, for example those between political priorities and technical realities, the complexity of EU legislation, the project-based funding issues, and the dependency on the European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice (eu-LISA). Despite these challenges, several best practices emerged, including the establishment of a cross-agency coordination platform and maintaining continuity of personnel. The study provides valuable insights for future endeavours, recommending flexibility in legislative and funding frameworks, sequential development of large-scale information systems (ISs), and early stakeholder engagement to enhance the implementation quality and feasibility of future EU ISs to name a few.

This thesis is written in English and is 84 pages long, including 8 chapters, 4 figures and 2 tables.

Keywords: large-scale information system, large-scale project, projectification, Entry/Exit System, EES, ETIAS, border control, challenges, best practices.

# Annotatsioon

# Euroopa Liidu suurte infosüsteemide rakendamine: riiki sisenemise ja riigist lahkumise ning Euroopa reisiinfo ja -lubade süsteemide juhtum Eesti näitel

Käesolev magistritöö uurib Euroopa Liidu (EL) suuremahuliste infosüsteemide rakendamist, keskendudes Eesti kogemusele riiki sisenemise ja riigist lahkumise süsteemi (EES) ning Euroopa reisiinfo ja -lubade süsteemi (ETIAS) rakendamisel. Uurimus kasutab juhtumiuuringu meetodit ja kvalitatiivse uurimistöö põhimõtteid, et analüüsida poliitilisi, õiguslikke, organisatsioonilisi ja tehnilisi väljakutseid arendus- ja rakendusetappides. Uurimus toob esile erinevaid väljakutseid, näiteks poliitiliste prioriteetide ja tehnilise reaalsuse vahelise vastuolu, ELi õigusraamistiku keerukuse, projektipõhise rahastamise probleemid ning sõltuvuse Vabadusel, Turvalisusel ja Õigusel Rajaneva Ala Suuremahuliste IT-süsteemide Operatiivjuhtimise Euroopa Liidu Ametist (eu-LISA). Vaatamata nimetatud väljakutsetele ilmnes mitmeid häid tavasid, sealhulgas asutustevahelise koordineerimisplatvormi loomine ja personali püsivuse tagamine. Uuring pakub väärtuslikke teadmisi edasiste algatuste jaoks ning soovitab muu hulgas õigus- ja rahastamisraamistike paindlikkust, suuremahuliste infosüsteemide järkjärgulist arendamist ning huvirühmade varajast kaasamist, et parandada tulevaste EL-i infosüsteemide rakendamise kvaliteeti ja teostatavust.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 84 leheküljel, 8 peatükki, 4 joonist, 2 tabelit.

Võtmesõnad: suuremahuline infosüsteem, suuremahuline projekt, projektiseerumine, riiki sisenemise ja riigist lahkumise süsteem, EES, ETIAS, piirikontroll, väljakutsed, parimad praktikad.

# List of abbreviations and terms

| | |
|---|---|
| BMS | Biometric Matching Service |
| EC | European Commission |
| EES | Entry/Exit System |
| ETIAS | European Travel Information and Authorization System |
| EU | European Union |
| EU MS | EU Member State |
| EU MSs | EU Member States |
| eu-LISA | The European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice |
| EURODAC | European Asylum Dactyloscopy Database |
| IT | Information Technology |
| IS | Information system |
| ISs | Information systems |
| MoI | Ministry of the Interior |
| PBGB | Police and Border Guard Board |
| PIKO | Border Control Information System |
| SBC | Smart Borders Committee |
| SIS | Schengen Information System |
| SIS II | Second generation of Schengen Information System |
| STSD | Socio-technical system design |
| SMIT | IT and Development Centre at the Estonian Ministry of the Interior |
| VIS | Visa Information System |

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# 1 Introduction

Since 2008, the European Union (EU) has envisioned establishing an Entry/Exit System (EES), a proposal initially outlined in the European Commission (EC) communication to enhance the EU's external border security and management. The purpose of the EES was to electronically record the data, time and place of entry and exit of third-country nationals who are entering the EU member states (EU MSs), providing data on migration flows directed toward the EU [1]. In 2013 the first 'Smart Borders Package' was proposed by the EC including two key measures: the establishment of an EES and a Registered Traveller Programme for third-country nationals crossing the EU's external borders. However, this proposal faced considerable reservations from the European Parliament, the European Council, the European Data Protection Supervisor, and civil society organisations [2].

The 2015 migration crisis exposed significant deficiencies in the EU asylum system. In response to these deficiencies and subsequent terrorist attacks [3], revisions were initiated to various databases, including those utilised for border control. In 2016 the *momentum* was right for the EC to introduce a new 'Smart Borders Package' [4], aimed to provide a strategic vision for the EU's border control and security data management architecture. The package included a communication that reviewed all current EU border management and internal security ISs, identifying improvements in data management. One identified gap was the absence of the EES, for which a proposal was submitted to the EU MSs for negotiations, with implementation expected by 2020. The other gap required further analysis: whether the EU needs a Travel Information and Authorisation System (ETIAS) for visa-required travellers to register their short journey details, similar to systems in the United States, Canada, and Australia [5], [6].

In 2017, the European Union regulation No. 2017/2226 came into effect, officially establishing the EES [7]. A year later, after the completion of the analysis mentioned in the previous paragraph, EU regulation No. 2018/1240 entered into force, establishing the European Travel Information and Authorization System (ETIAS) [8]. Following the enactment of both acts, the EC and EU MSs started negotiating over implementing acts

and in parallel initiated the development of their national ISs through projects funded by EU grants designated for the relevant policy area. The European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice (eu-LISA) was tasked with the development of the EES' and the ETIAS' central system. While each EU MS is responsible for the IT development in their own country and eu-LISA is responsible for the EU central systems, the EC has the authority to determine the deployment dates of both systems according to these acts [7], [8].

According to the latest available public information, the EES is scheduled to launch in October 2025, with a progressive implementation approach introduced. In the last quarter of 2026 the ETIAS is anticipated to become operational [9]. Despite the political commitment, existing legislative framework, and allocated finances, implementing both ISs has experienced multiple delays over the years [10], [11], [12], [9]. The eu-LISA was tasked with developing central components by contracting large companies and EU MSs must wait to begin developing interfaces until the central systems are complete [13]. The delays are attributed mainly to the external contractor who has faced challenges in developing the EES, as well as failures to execute and deliver of specific milestones [10], [11], and to EU MSs who are progressing at their own pace [14].

## 1.1 Problem statement and research objective

Successful implementation of large-scale EU ISs, such as the EES and ETIAS, relies heavily on the experiences and capacities of the individual EU MSs. Without systematically analysing EU MS experiences, it is difficult to identify factors that support or hinder effective implementation. Identifying these factors can not only aid in addressing the current implementation challenges but also provide actionable insights for the development of future EU information systems, ensuring better allocation of resources, stakeholder coordination, and technical feasibility. Understanding these factors is critical because the EU large-scale information systems, are cornerstones of EU-wide policy objectives, including enhanced border management and security that use the EES and ETIAS for this purpose. Without this understanding, the EU and EU MSs risk inefficiencies, delays, and potential failures that could compromise the intended goals of such critical systems.

However, there is limited empirical understanding of the experience (*or specific challenges*) encountered by EU MSs during the implementation, and how this experience (*these challenges*) affects the development process and later implementation success of these ISs at the national level. This study addresses this gap by identifying key challenges and proposing practical solutions for addressing them.

Although the author was not directly involved in implementation process of neither the EES nor ETIAS, Estonia was selected due to the author's professional familiarity with the national context and ease of access to key stakeholders. Estonia's implementation experience offers a unique perspective for examining the interplay between institutional capacity, technical challenges, and policy compliance in the implementation of the EES and ETIAS. Consequently, this study addresses the research gap by examining Estonia's experience with implementing the EES and the ETIAS.

The findings from this study aim to provide insights and best practices that could inform and thereby improve the planning, management, execution and deployment of future large-scale EU information systems.

## 1.2 Research questions

The goal of this research is to provide practical insights and propose practical solutions for future development and implementation of large-scale EU ISs by examining the experience of Estonian authorities when developing and implementing the EES and the ETIAS.

The findings from this study aim to enhance the planning, management, and execution of future large-scale ISs in public administration by identifying key factors that affected the development and implementation of the EES and the ETIAS in Estonia.

Based on that aim, the following main research question (RQ) was formulated:

**RQ1: How can Estonia's experience with implementing the EES and ETIAS inform the development of large-scale EU ISs in the future?**

The main RQ1 is designed to address the overarching objective of this study: to extract actionable lessons from Estonia's experience with the EES' and ETIAS' implementation for future EU ISs developments.

To address the main research question, it is crucial to provide a structured approach to examine specific dimensions of the implementation process and therefore the RQ2 and its two sub-questions (SQ) were formulated. They enable the identification of policy-related, legal, organisational, and technical challenges and allow analysis of the impact on the national implementation of the EES and ETIAS.

**RQ2: How have Estonian authorities experienced the implementation of the EES and ETIAS across policy, legal, organisational, and technical dimensions?**

The following SQs support the exploratory case study methodology and ensure a comprehensive thematic analysis of the qualitative data collected through interviews an documentation:

**SQ2.1: What policy-related, legal, organisational and technical challenges have influenced the process of implementing the EES and the ETIAS in Estonia?**

**SQ2.2: What effects, if any, have these challenges had on the implementation process at national level?**

These research questions form the basis for the empirical investigation undertaken in this study, thereby supporting the achievement of the stated research objectives.

## 1.3 Structure of the Thesis

This thesis comprises of eight chapters, with chapter 2 providing insights to the theoretical framework focusing on socio-technical systems theory and theory of temporary organisations. Chapter 3 reviews literature on European infrastructure, digital border management, challenges of large-scale government and IT projects, and the evolution and issues of other EU large-scale ISs. Chapter 4 explains the chosen research methodology, specifically the application of the case study approach and qualitative research conducted. Chapter 5 presents the research findings and insights gathered from conducted interviews. Chapter 6 correlates the research findings with the objectives of this thesis. Chapter 7 analyses the limitations of this research and offers suggestions for future research. The final chapter 8 brings out the main findings of this research and concludes the current thesis.

The author has integrated preliminary research undertaken in 2024, initially conducted as part of various course assignments and written essays on the topic, into this thesis. This initial research was subsequently expanded into the research proposal for the current thesis within the framework of the e-governance technologies and services master's programme.

# 2 Theoretical framework

Nowadays most computer-based systems are socio-technical systems, involving interactions between people, technology, and their operating context, such as organisational or physical environments [15], [16, pp. 593–594]. Although socio-technical issues have been analysed through actor-network theory [17], this study uses a traditional socio-technical systems theory approach. This choice is due to the socio-technical complexity and multi-organisational context of the EU-wide IT systems. The study focuses on the interaction between the technical infrastructure of the EES and ETIAS, and the policy-related, organisational and legal structures into which these ISs are integrated.

Clarke et al. [18] cite: 'socio-technical systems theory and related design methods are built on open systems thinking' and admit that systems are composed of technical components that work dependently with social and/or human part [18]. The socio-technical systems theory provides a structured method for implementing socio-technical interventions and designs, aiming to balance human values and technological abilities. Clarke et al. [18] have suggested that developers of public sector ISs need to adopt design methods that incorporate socio-technical insights [18].

Socio-technical system design (STSD) methods ensure that both technical and organisational aspects are considered. These methods help understand how human, social, and organisational factors influence work and the use of technical systems. STSD methods can be applied to designing organisational structures, business processes (service provision), as well as technical systems. Socio-technical systems engineering that applies STSD methods is inherently interdisciplinary and applies research from different fields for example, ISs, cognitive systems engineering, and human-computer interaction to name a few [16, pp. 593–594].

Moultrie [19] has noticed that there has been a renewed emphasis on the need for designers to address increasingly complex socio-technical issues. These issues are characterised by their dynamic nature, with different components changing at varying

rates; their non-linear progression, lacking straightforward cause-and-effect relationships; their emergent properties; often large scale, such as societal transformation; substantial social and technical complexity; and high levels of unpredictability. All design decisions have wider and occasionally unforeseen effects, some of which might not be immediately obvious [19].

Conversely, techno-centric approaches overlook the complex relationships between the organisations, the people who implement business processes, and the supporting computer-based systems. Baxter and Sommerville [16, pp. 593–594] claim that although developers may assert that a socio-technical approach has been implemented, the initial separation of the system into social and technical components indicates a disregard for their interconnection [16, pp. 593–594].

*Guide to the Software Engineering Body of Knowledge* (SWEBOK) [20] cites Ian Sommerville: 'a system is a purposeful collection of interrelated components that work together to achieve same objective'. Systems can be classified into technical computer-based systems and socio-technical systems based on human involvement. Technical computer-based systems operate without human intervention, examples include televisions, mobile phones, and certain software. In contrast, socio-technical systems require human participation to function, such as systems 'manned space vehicles, chips embedded inside a human' [20]. Despite the automation of border control activities—enhanced by the implementation of the EES and ETIAS and the introduction of new technical devices such as automated border crossing gates—these systems remain socio-technical in nature, as they require human input, either from a border guard as a user or a third country national as a subject (a *usee*).

In addition to socio-technical systems theory, current study uses the theory of temporary organisations, developed thirty years ago, to understand the management of national-level implementation of EU-wide systems. The rollout of the EES and the ETIAS is structured around time-bound, goal-oriented project units that rely on cross-institutional collaboration under external political pressure. Temporary organisation theory helps frame the coordination challenges, resource bottlenecks, and ambiguity that emerge during such developments and implementations.

According to Godenhjelm et al. [21] the fundamental components of a temporary organisation, regardless of the context, consist of time, task, team, and transition [21], also referred to as the 4 T framework. The concept of temporary organisations and its 4 T framework significantly influenced research on project management and played a crucial role in bridging the gap between academic studies in project management field, and the fields of management and organisational studies. Noted by Sydow et al. [22] the theory conceptualises projects as 'being temporary organisations with a particular focus on the reception and elaboration' of the 4 T framework. Within this framework '*time*' represents temporariness, which is a distinct conditional feature of a project, whether 'institutionalised termination' occurs by a specific date or event. '*Task*' denotes the reason for the existence of the temporary organisation and the provision of necessary resources, including technology use, identity formation, and goal orientation. These tasks are carried out by a '*team*' of actors who may be specifically hired to implement the project or dispatched from a permanent organisation. The team's efforts, either throughout the duration or after the termination of the project, should result in a transformational 'transition' concerning either a product or process [22]. However, Jensen [23] has noticed that many false projects are in circulation—tasks to be accomplished and duties fulfilled mispresented as projects [23].

Sydow et al. [22] have proposed to extend the 4 T framework via lenses of '*project plasticity*' i.e. 'the potentially tension-ridden capacity of a project to change lastingly and nevertheless stay the same in the eyes of those involved, at least until the project's termination' [22]. In 1999 Midler believed that the concept of '*projectification*' in the public sector originates from the utilisation of projects within the private sector, where project management is considered an effective and flexible organisational approach as cited by Godenhjelm [24]. Munck af Rosenschöld [25] has explored how institutional change occurs in the context of projectified governance and projectification, particularly when the policy goals are implemented through projects. An adaptive projectified governance mode is proposed to facilitate the change [25]. Mc Glinn's [26] research indicates that project-management logic tends to transform complex problems into 'short-term, goal-oriented, and budget-sensitive solutions' [26] and Fred [27] has noticed that the project logic appears to be aimed at 'organisational clarity, order and control—thus strengthening the bureaucratic principles' [27].

It is essential for modern societies to understand how stable forms of collective action can align with transient and dynamic project organisation. This understanding is vital in addressing a key socio-economic challenge, as these societies must undertake ‘urgent, significant, and varied transitions’ [28, p. viii]. Furthermore, since the ETIAS and the EES stand out as pivotal electronic travel systems on a global scale [29, p. 17], they are particularly interesting subject of research.

Current study integrates socio-technical systems theory with the theory of temporary organisations, effectively capturing both the persistent structural constraints and the temporary project conditions that influence the implementation of large-scale EU IT systems at national level.

# 3 Literature review

This chapter provides a comprehensive overview of academic literature relevant to examining the experience and challenges encountered by Estonia in the development and implementation of the EES and ETIAS. It explores existing academic discussions and identifies key debates surrounding different EU initiatives. Furthermore, the chapter synthesises insights and lessons learned from relevant cases, thereby establishing an analytical foundation for understanding Estonia's experiences and positioning them with broader European context.

To conduct a comprehensive literature review, the scientific database Scopus and Google Scholar were used due to their wide coverage of peer-reviewed academic publications, conference proceedings, and grey literature relevant to the field. Keywords such as 'sociotechnical systems', 'digital transformation', 'e-government', 'projectification', 'large-scale project', 'large-scale ICT project', 'IT project', 'success factors', 'IT project failure', 'large-scale IT systems', 'large-scale information systems', 'entry exit', 'Entry/Exit', and 'SIS' within search fields were used. Apart from the publications by the Centre for European Policy Studies and the University of Gothenburg, two conference papers, and two EU legal acts, all other sources referred to in this chapter are from peer-reviewed sources.

The first section introduces literature related to European infrastructure and digital border management; the second section examines various challenges and barriers encountered during implementation of large-scale government and IT projects; and the final section explores the evolution and challenges related to EU large-scale ISs in the field of internal security.

## 3.1 European infrastructure and digital border management

The historians of technology F. Schipper and J. Schot have proposed the term '*infrastructural Europeanism*' meaning that Europe has historically developed its political space based on transportation networks, supply chains, and energy

infrastructures. Infrastructure provides insight into continuous processes involving decisions, negotiations, and the movement of people and goods [30]. Technological innovation undoubtedly affects the interpretation of the term '*infrastructural Europeanism*' because technical issues have political implications as they influence the infrastructural capability to regulate international mobility [31] and migration.

In 2016, the EC highlighted in its communication on 'Stronger and Smarter Information Systems for Borders and Security' that 'EU citizens expect external border controls on persons to be effective, to allow effective management of migration and to contribute to internal security'. Moreover, the communication proposed that the structural improvement of the EU data management architecture for border control and security via interoperability should make the border control more effective and efficient. As regards the establishment of the EES, it would 'allow for the effective management of authorised short-stays, increased automation at border-controls, and improved detection of document and identity fraud' [5]. According to Draheim et al. [32] who analysed the core narratives and discourses related to digital government claim that technocracy is about having experts as high-level political decision makers (policy makers) treating efficiency and effectiveness as primary goals leaving other aspects as secondary concerns [32].

The communication [5] emphasised also the positive aspects of using biometric technology, particularly in relation to the protection of individuals' fundamental rights. 'Making full use of technological developments' were considered equally important as the purposeful application of technology in compliance with 'privacy by design' principle and outlined the outmost importance of the EES related legislative proposals aiming their adoption by the end of 2016 [5]. From the digital transformation perspective the communication [5] underlined that the EES brings the opportunity to change practices of border control procedures and stamping of travel documents will be discontinued. Although the efforts of digital transformation represent significant improvements for 'public sector organisations to become more effective and efficient in their process and outputs', Mergel et al. [33] argue that it is increasingly imperative not to merely focus on the benefits of available technology but turn the attention also to 'social constructions, behaviours, attitudes and cognitions of individual actors or transformational change'. They highlight that digital transformation is a process that is affected by external factors, such as the use of new technologies by stakeholders of public administrations [33].

The EES and ETIAS exemplify cross-border government-to-government e-government services. These systems facilitate data exchange concerning third-country nationals from national databases in the EU MSs via centralised system administered by the eu-LISA. Draheim et al. [32] have noticed that the tech-savvy narrative frequently emphasises a focus on technology and a positive outlook. They state that this perspective may occasionally neglect the systemic nature of e-government, particularly concerning disruptive technologies. The argument that IT is accessible and should be utilised to transform public administration or the whole society is among the most prevalent in the tech-savvy narrative [32].

In 2018, Khan and Efthymiou [34] conducted a case study on the implementation of biometric technology within the framework of the entry-exit program at United States preclearance facilities at Dublin airport. They identified challenges associated with network connectivity issues and infrastructure. Interviews with industry professionals revealed that while the technical match rate for facial recognition was high, the biometric confirmation rate required further improvement, which could be addressed through process enhancements. The researchers concluded that customs and border protection services should collaborate with stakeholders to resolve network and staffing issues, thereby ensuring timely passenger processing and aircraft departure performance to avoid inefficiencies due to system disruptions. Additionally, continuous improvement of algorithms to increase match rates is essential, alongside educating travellers on the necessity and usage of such data to alleviate privacy concerns [34]. Nonetheless, this study does not address the gap concerning the challenges associated with the implementation of such systems but focuses on technology use in service provision (business processes).

## 3.2 Challenges of large-scale government and IT projects

The impact analysis that accompanied the EC's proposal for the EES regulation states that 791 million euros was set aside from EU funds as an indicative amount for all the system's development [35] and the estimated development cost of ETIAS is 212.1 million euros [36]. Flyvberg [37] characterises investments amounting to at least billion dollars, which require many years to develop and construct, involve multiple public and private stakeholders, are transformative, and affect millions of people as 'megaprojects'—large-

scale ventures with high-level complexity [37]. Although the current thesis focuses specifically on Estonia's perspective of these systems, understanding the 'megaproject' context helps frame the scale and complexity of the challenges involved. Moreover, overall increased reliance on phenomenon 'the project' as an organisational function or form is grasped by the projectification concept. In the project management discipline, a project is defined as 'a temporary endeavour undertaken to create a unique product, service or result' [38]. Researchers have noted that in recent decades, projectification as a temporary form of organising has escalated in the public sector. The EU has played an important part in the expansion of projects and projectification of the public sector because projects and project funding are the main instruments for implementing the EU policy [38]. Conversely, Mergel et al. [33] claim that although the potential of digital transformation is recognisable, its actual impact on the public sector cannot be unambiguously highlighted. This suggests that digital transformation is perceived as an indefinite process, 'unlike previously designed e-government projects with a start and end date, a measurable and defined end status, as well as a fixed budget'. Instead, digital transformation necessitates continuous adjustments to accommodate external requirements [33].

Patanakul et al. [39] have identified six key characteristics of government projects that contribute to their complexity: (1) non-financial benefits are gained as a result; (2) long-term utilisation of the product (or service) is expected; (3) multiple stakeholders are involved; (4) their scale is large, with a lot of complexity involved; (5) they are initiated and built in complicated and changing political environment; and (6) formalised processes (budgeting, planning, implementation, governance, monitoring, auditing) are required during completion [39]. Zwikael and Gil-Garcia [40] have emphasised in their study the importance of the exhaustive preparation phase (the front-end) of the complex projects to support quality decision-making and an informed investment decision before complex projects are initiated [40]. Alami's [41] study on IT projects concluded that projects operate within their unique ecosystems due to inherent differences. Projects' ecosystems mirroring real-world conditions often exhibit volatility, uncertainty, complexity, and unpredictability. Inadequate management of one or more of these characteristics can result in an unbalanced ecosystem, potentially leading to project failure. Since projects' ecosystems are partly derived from the organisation's ecosystem,

future projects will exhibit similarities in their ecosystem compositions. Therefore, analysing actual failures is essential for learning and improving future projects [41].

The literature review on IT project success factors conducted by Iriarte and Bayona [42] highlighted that there is no single definition of project success, and the authors defined it based on criteria related to project management, product quality, stakeholder satisfaction, and project benefits. Their literature review finds that while management criteria are similar across projects, IT projects emphasise product quality, user satisfaction, and the impact on organisations and users. The most mentioned success factors include top management support, user involvement, internal communication, knowledge and technical expertise of consultants, and effective planning. To synthesise the wide range of factors identified, the authors introduced a structure based on attributes (such as support, involvement, or expertise) and objects (such as team members, users, or planning), revealing that human and soft skill-related factors are the most prominent. Their conclusion stresses that aligning people, processes, and context is key to achieving IT project success [42]. On the other hand, one of the core findings in the Hughes et al. [43] case study is that unrealistic expectations, complexity, and large project scope are among the key contributing factors to failure [43].

## 3.3 Evolution and challenges of EU large-scale information systems

Several research papers [31], [44], [45], [46], have investigated EU large-scale ISs, particularly in the domains of security, border control, and migration, from various perspectives.

Leese and Ugolini's [46] research paper concentrates on the evolution side of the Schengen Information System (SIS), another crucial EU database for immigration and border control that experienced similar postponements. Researchers have indicated that ‘historical political conditions’ and a legal opportunity window made the SIS more powerful than intended, causing deployment delays. The paper states that second generation of the Schengen Information System (SIS II) was designed with ‘dormant functions’ that could be activated later, enabling the system to evolve and expand. This approach has resulted in a flexible and scalable technological system that can be easily upgraded. The analysis also emphasises the role of political and bureaucratic actors as technological agenda-setters in international and national security contexts. Furthermore,

the document suggests that making the 'politics of creep visible and public' can foster democratic debate and reclaim control over technological expansions [46]. Similarly has Parkin [44] explored the challenges faced in developing the SIS II and concluded that besides significant delays, the project experienced also budget increases, political crises, and concerns about its impact on fundamental rights. Parkin's article examined the decision-making processes over the decade and concluded with policy recommendations for future development of large-scale EU IT systems. From the viewpoint of the current thesis the most significant recommendations are: (1) 'no new database should be set up until SIS II is' proven to be proportionate, safe and reliable and if the development is delegated to the EU MSs, their financial and legal accountability must be ensured; (2) 'overambitious political timetables should be avoided' to prevent budgetary oversight issues and ensure proper democratic and judicial scrutiny of new security technology measures; (3) respect for fundamental rights and data protection should be central to future policy strategies. This includes independent assessments of the impact of new databases and ensuring data protection by design [44]. However, Parkin did not concentrate on the challenges faced by the individual EU MSs and recommendations were directed to better policymaking at EU level.

Bellanova and Glouftsios [31] have examined the interaction of social, political, and technological factors in the development of border controls, using the SIS II as a case study. Their paper emphasises the importance of addressing the fragility and maintenance of such infrastructures to challenge the effectiveness of control measures and to understand the role of various actors, including maintainers and repairers, in border control [31]. Moreover, Glouftsios [45] has observed that maintenance labour necessary for large-scale ISs like SIS II and VIS to ensure their functionality is often overlooked 'technological work'. It argues that understanding maintenance practices is crucial for appreciating how these systems govern international mobility and suggests a broader analytical approach to maintenance, focusing on the processes that sustain security infrastructures, including breakdown and repair, which are essential for their durability and persistence [45].

In the framework of Estonian case study on implementation of information security for the ISs EURODAC, SIS II, and VIS Järvsoo et al. [47] have studied policy making and management process of the EU ISs [47]. They concluded that the management of EU ISs involves a significant amount of bureaucracy, which can be deemed necessary to operate

large-scale systems. Decision-making processes are slow due to multiple levels of authorities. Cooperation between eu-LISA and EU MSs is mostly based on necessity and regulatory requirements, but knowledge exchange remains weak [47].

Although the studies reflecting challenges related to the EES and ETIAS have not been published by the time the current thesis was written, given the scale of the EES system, potential data sharing issues, and the integration of biometric technologies, this subject has gained wider interest among scientists and has directed the research focus also for the Information Technology Department at the University of Gothenburg [48, p. 8].

Existing literature highlights potential disparities between political decision-making and the realities of technical implementation in large-scale public sector IT projects [33]. For instance, the EES and ETIAS implementation deadlines have faced multiple postponements [9], [10], [11], [12] as publicly acknowledged and such postponements suggest underlying governance and socio-technical challenges that merit closer empirical investigation.

# 4 Methodology

In order to address the research questions, this study employs a case study research methodology and applies qualitative research principles [49, pp. 28–29] to examine the challenges related to the implementation of the EES and ETIAS in Estonia. Additionally, it will explore lessons learned and best practices that can be applied to future large-scale IT projects. The research process is illustrated in the figure 1.

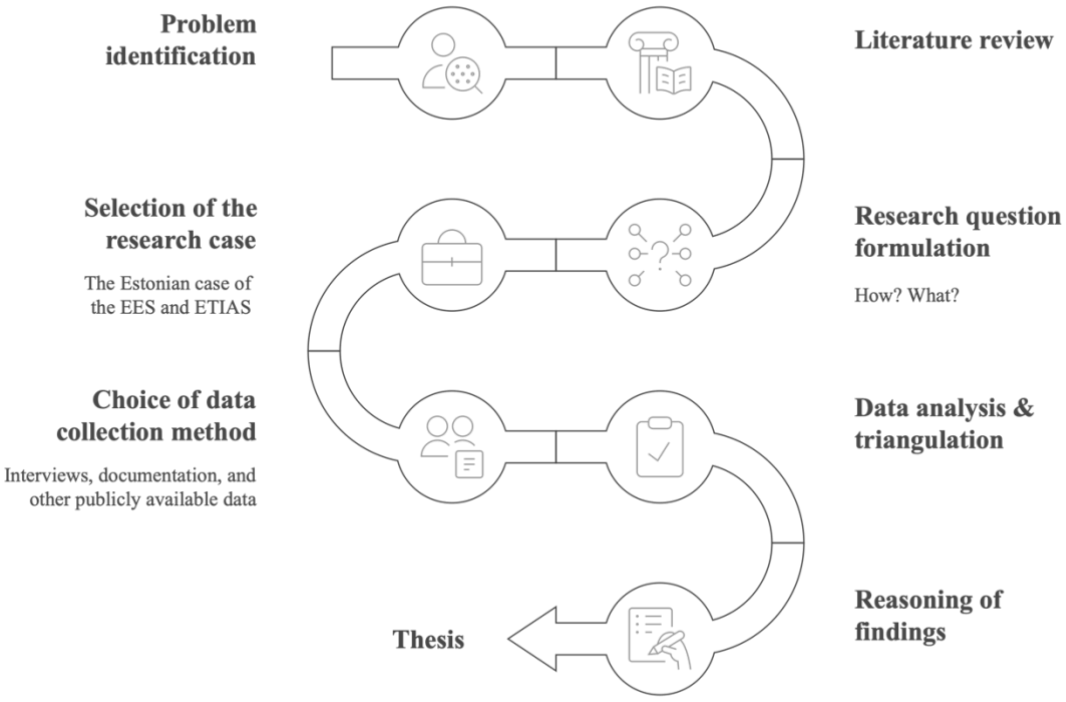


Figure 1. Research Process.

Given the limited prior knowledge on the barriers faced in the development and implementation of the EES and ETIAS and the objective of this research to thoroughly examine these challenges without any predefined hypotheses, an exploratory approach is deemed the most appropriate. Since the study is conducted in real-world settings, it corresponds to the definition of case study referred to in Wohlin's and Rainer's study:

‘Case studies are by definition conducted in real world settings, and thus have a high degree of realism, mostly at the expense of the level of control’ [50]. The use of the case study research method allows to take advantage of its major strength in data collection – employing different sources of evidence [51, p. 15]. Following the checklist provided by Wohlin and Rainer gives assurance that labelling current research as a ‘case study’ can be considered correct [50].

## 4.1 Data collection

For this research, data was sourced from two main types of evidence: an exhaustive review of publicly available information and semi-structured interviews conducted with Estonian government officials responsible for policymaking and legislative drafting, officials from the authority who are responsible for implementation of the EES and ETIAS regulations, and technical experts from Estonian authority who are responsible for information and communication technology development regarding the EES and ETIAS.

The primary data for this research was collected through semi-structured interviews. The purpose of the interviews was to explore experiences, perspectives, and interpretations of the challenges faced during the development and implementation process of the EES and ETIAS to address all the research questions and sub-questions. The semi-structured interview questionnaire included questions structured according to pre-defined topics: policy related, legal, organisational, technical challenges, and lessons learned, with primary emphasis on exploring the challenges faced and lessons learned from the preparatory and implementation phase of the EES and ETIAS. The questions of the semi-structured interview are presented in the appendix 2 (English) and the appendix 3 (Estonian).

In addition to primary data, the publicly available information was used to validate the claims of interviewees and strengthen the interpretative robustness of the qualitative findings. The key EU policy documents relevant to the design and implementation of the EES and ETIAS, including impact assessment accompanying the ESS regulation proposal, documentation from the Smart Borders Committee (SBC) responsible for expressing opinions that shaped the implementing acts of the EES and ETIAS, industry round table summaries and reports produced by the eu-LISA, and other publicly available records were used as secondary data sources to gain insights on the research case. These

materials will support the analysis by offering documentary evidence of policies, decisions, and technical details and help to understand the formal requirements, timelines, and expectations set by the EU and Estonian authorities.

By combining primary and secondary data, this research employed data source triangulation to answer the research questions and achieve the goal of the study. Cross-checking the primary data with secondary sources ensures reliability and helps to strengthen the construct validity of the case study [51, p. 128]. Use of data triangulation approach improves the credibility of research findings and reduces potential biases.

For the selection of interviewees, a combination of purposive and snowball sampling methods was used [52]. Firstly, in the purposive sampling phase, the interviewees were selected by the author based on their relevance (e.g., role, experience) to the study's objectives. This method ensured that the initial participants align with the research focus and represent various positions within relevant Estonian authorities—the Ministry of the Interior (MoI), the Police and Border Guard Board (PBGB), IT and Development Centre at the Estonian Ministry of the Interior (SMIT)—providing perspectives on different actors and challenges at various implementation stages of the EES and ETIAS. The sample was then expanded using the snowball method, where the initial interviewees refer additional individuals who are also pertinent to the study. This approach facilitated access to individuals with specialised knowledge who could provide further perspectives on the study within an established network that might perceived as rather small but gathers nearly all officials who have been directly participated in the EES and ETIAS implementation process. Altogether 11 interviews were conducted, and the interviewee affiliations are presented in table 1.

Table 1. Interviewee affiliations.

| **Interviewee** | **Role in the preparatory, development and implementation phase (of the EES or ETIAS or both)** |
|---|---|
| A | Advisor to the Ministry of the Interior on EU funding (EES, ETIAS) |
| B | Coordinator of IT developments the Ministry of the Interior (EES, ETIAS) |
| C | Former Advisor to the Policy Department of the Ministry of the Interior (EES) |
| D | Interoperability Project Manager of the SMIT (EES, ETIAS) |

| | |
|---|---|
| E | Former Estonian Representative in the eu-LISA Management Board (EES, ETIAS) |
| F | Project Manager at the PBGB (EES) |
| G | Technical Expert of the SMIT (EES) |
| H | Project Manager at the PBGB (ETIAS) |
| X | Legal Advisor of the Policy Department of the Ministry of the Interior (EES, ETIAS) |
| J | Advisor to the Policy Department of the Ministry of the Interior (ETIAS) |
| K | Technical Project Manager of the SMIT (EES) |

Each interviewee was contacted individually via phone or email to schedule an interview. Prior consent was obtained from all interviewees for the recording the interview. Interviewees were also assured that their names will remain confidential and will not be published even if their direct quotes are used to illustrate a finding. The interviews were conducted in Estonian language in person or remotely (via Microsoft Teams) between January and March 2025. The interviews lasted between 25 and 80 minutes with average duration 52 minutes. The interviews were transcribed using the dictation feature in Microsoft Word and translated into English with the assistance of Microsoft Word Copilot. The transcription was proofread, corrected, and lightly edited for grammar and clarity without altering meaning, to conduct the thematic analysis.

## 4.2 Thematic analysis of interviews

The interview data was analysed utilising both deductive and inductive coding methodologies. Deductive coding, anchored in framework analysis [51, pp. 171–172], concentrated on topics extracted from the research questions (policy-related, legal, organisational, technical challenges, and lessons learned), hereinafter referred as ‘main themes’. Inductive coding, adhering to grounded theory principles [51, p. 169], enabled the emergence of novel themes directly from the data, employing a descriptive approach to ensure that all relevant participant-driven concepts were captured comprehensively. The transcripts were examined multiple times to gain familiarity with the data and identify concepts and ideas.

Thematic analysis of the transcript was conducted using computer assisted qualitative data analysis software Quirkos [53]. In addition to main five themes derived from research questions 10 descriptive codes emerged: ‘dependencies on other ISs’, ‘biometry’, ‘IT infrastructure’, ‘interoperability component’, ‘building infrastructure challenges’, ‘public procurement and contractual issues’, ‘data protection’, ‘best practices’, ‘opportunities’, and ‘suggestions for the future’. These emergent descriptive codes were subsequently integrated into and organised under the corresponding five pre-defined main theme codes. This integration was based on the main theme with which they showed the most overlap, thereby refining and enriching the thematic framework.

Three inductive codes emerged during analysis that did not align neatly with pre-defined main themes. These included ‘delays and unfeasible deadlines’, ‘project-based funding’, and what was later conceptualised as ‘detailed and restrictive EU legislation’. While the first two were coded explicitly in Quirkos, the third was identified during the interpretive state of thematic analysis, based on recurring concerns expressed by the interviewees across multiple codes—particularly legal challenges. These three codes were treated as cross-cutting or contextual factors that influence or mediate the experience of implementation challenges. Accordingly, they were analysed in the separate sub-chapter under results and presented in the discussion as overarching meta-themes.

The emerging code ‘Estonia’s contextual uniqueness and advantages’ was employed to identify and formulate the limitations of the results findings within the corresponding chapter of the current research.

However, not all emerging codes developed into themes, either due to limited recurrence across interviews (such as ‘interoperability component’ and ‘opportunities’) or lack of triangulating data (such as ‘data protection’). These were retained at the coding stage but integrated where relevant into main themes.

During the coding process, two organisational labels—‘ETIAS’ and ‘Other related topics’—were used solely as reference tags to group content for internal navigation and thematic orientation. These were not treated as analytical codes and were not included in the formal thematic analysis.

The thematic analysis of the interviews yielded 20 coding results, including 15 emergent descriptive codes, with a total of 1,196 codes. The map of codes used in thematic analysis is presented in the appendix 4.

## 4.3 Document analysis for triangulation

In addition to interview data, a selection of the EU policy documents, impact assessments, and implementation-related records (including SBC documents) were reviewed to support data triangulation. These documents were chosen based on their public availability and direct relevance to the activities related with development and implementation of the EES and ETIAS systems.

A thematic analysis was applied to these sources using the same deductive pre-defined themes (policy-related, legal, organisational, technical challenges) to identify statements, assumptions, or timelines relevant to the context. The primary purpose of the document analysis was not to generate new findings, but to validate and contextualise participant accounts and highlight potential misalignments between official expectations and practical experiences.

These triangulation sources were used selectively in the results and discussion chapters to support or contrast with interview-based themes.

# 5 Results

This study explores legislative, organisational, and technical challenges experienced, as well as lessons learned, and best practices gained during development of the EES and ETIAS in Estonia. The current chapter introduces the results of thematic analysis concluded after data collection and semi-structured interviews.

The development and implementation of the above-mentioned information system is the responsibility of the MoI and government agencies in its governing area—the PBGB and the SMIT. The MoI is responsible for representing Estonia and negotiating the draft regulations at the EU level in the relevant Council working groups as well as expressing opinion in the SBC [54] where the drafts of implementing acts were discussed. Officials who were fulfilling these tasks are included in the current study as interviewees. The MoI is also responsible for drafting subsequent amendments to national legislation and represent Estonia at eu-LISA Management Board [55]. The PBGB is responsible for implementing the legislation and managing the business aspects of border management and control, which includes the necessary ISs for providing this service. The PBGB officials attend also the EES-ETIAS Advisory Group meetings chaired by the eu-LISA [56]. The SMIT is responsible for the development of ISs and the procurement of technical equipment necessary for the PBGB's operations. Additionally, the SMIT officials participate in expert group meetings organised by the eu-LISA.

All interviewees have been involved in the development and implementation of either the EES, ETIAS, or both for a minimum of five years. They possess significant knowledge and substantial expertise relevant to the objectives of the current study, which seeks to provide insights into the planning, management, and execution of these systems.

The following sub-chapters present the results of the thematic analysis and follow the structure of main themes of interview questions (policy-related, legal, organisational, technical challenges, lessons learned and reflections) with an addition of contextual themes that emerged from the interviews incorporated in the separate sub-chapter as illustrated in the figure 2.

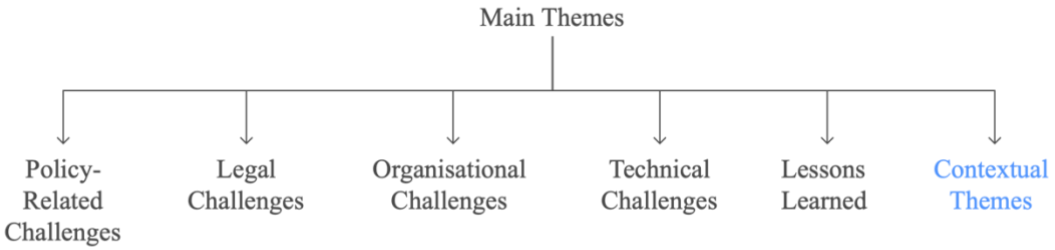


Figure 2. Structure of thematic analysis.

## 5.1 Policy-related challenges

To explore policy-related challenges, interviewees were asked to reflect on how policy-related considerations influenced the development and implementation of the EES and ETIAS in Estonia. Specifically, they were invited to address the following questions:

- How did policy-related considerations influence the development and implementation of the EES and ETIAS in Estonia?
- Were there any significant challenges or opportunities that emerged, and how were they managed?
- How did the requirements set by the EU level legal framework shape Estonia's approach to the endeavour?

Majority of interviewees (A, B, C, D, G, H) described a significant **mismatch between the political priorities** (policymaking) **and set deadlines** considering the complexity of the systems involved.

One interviewee summarised the situation: '*The ministers agreed on a deadline—and it was missed. Now they are agreeing on a new deadline.*' Another interviewee expressed: '*Sometimes, expectations are adjusted to be more realistic, considering the political desire to "create a system that integrates everything" or "we need such a system." It's important to consider the realistic timeframe and the collective effort required from all Member States, both financially and in terms of time.*' The third interviewee had a similar view: '*Expectations and reality are somewhat different.*' '*The regulation is based more on idealistic considerations and perceptions, rather than reality*,' reflected the fourth

interviewee and explained: '*... very often all these are tied to a political agenda, someone wants to get something done—then preparation is the last thing to think about*.'

The EES draft regulation impact assessment identified a challenge related to the timeframe if the functionalities of the EES and registered traveller programme (later known as ETIAS) were combined, acknowledging an increased project management risk due to the 'time-restricted project phase' [57]. Additionally, ETIAS draft regulation's explanatory memorandum did not address the timeframe issue [36]. The eu-LISA Programming Document 2018-2020 identified a challenge related to EES deadline specifically concerning potential delays in 'the legal proposal approval process and implementing decision' [58, p. 163]. Additionally, the eu-LISA Programming Document 2019-2021 addressed a challenge concerning several components of ETIAS that 'are expected to be shared with EES,' introducing dependencies between 'such large projects' which could result unforeseen delays. 'The intended year for entry into operation is considered very challenging, perhaps unmanageable' [59, p. 149]. The subsequent eu-LISA Single Programming Document 2021-2023 repeated ETIAS' concerns regarding dependencies between large project and unexpected delays, estimating the timeframe as follows: 'the intended year for entry into operation is considered as very challenging and overly optimistic' [60, p. 105]. Finally, in the Consolidated Annual Activity Report 2021 of eu-LISA gave an overview of technical difficulties that caused serious delays and resulted in the postponement of EES and ETIAS release delivery [61, pp. 16, 24–26, 27–28, 145, 148].

This finding reflects how political-level urgency can overshadow technical realities and highlights the key organisational challenges in coordinating legislative drafting and large-scale IT systems implementations.

## 5.2 Legal challenges

To examine legal challenges encountered during the implementation of the EES and ETIAS, interviewees were asked to consider how national legal frameworks influenced the process. They were invited to respond to the following questions:

- How did Estonia's existing legal framework influence the implementation of the EES and ETIAS?

- Were there any specific aspects that required adaptation or posed challenges?
- In your experience, were there any notable considerations or obstacles in aligning the EES and ETIAS with Estonia's legal requirements? How were these addressed, if applicable?

All participants identified various legal challenges encountered during the development and implementation of the EES and ETIAS. These challenges involved legislative drafting both at the EU and national level, as well as the application of EU law.

Although EU regulations are directly applicable, the EU MSs must establish **legislation to ensure their enforcement at national level**. As the interviewees (B, C, D, G, H, I, J) reported, variety of challenges were faced in choosing the existing legal national framework the EU acts will complement, designating competent authorities, ensuring their legal access to data, defining and aligning the elements of criminal offences, ensuring high standards of data protection, defining national procedures, and setting deadlines for these arrangements to be implemented nationally. If the EU legislation gets amended as was proposed by the EC in the late 2024 [62], the same national legislative process starts again (albeit on a smaller scale).

As highlighted by Interviewee X: '*The more EU ISs come into play, and the more we adopt and integrate them, the more complicated our domestic law becomes. … It becomes more complicated, and we burden our legal system quite a bit with it.*'

The national legislative drafting process and all the documents can be traced via Estonian public information system EIS (information system for legal drafts) [63], [64] where the evolvement and complexity can be observed.

Two interviewees highlighted concerns about **particularly detailed legislation concerning technology to be used for the EES**. An example was brought regarding biometrics. One interviewee mentioned that requirements were established for the system, including capturing biometric and travel document data from third-country nationals subject to EES regulations. The biometric requirements were set very high, like those for a document photo. Moreover, the other interviewee noted that the regulation specified that facial capture and comparison should have been applied from the age of zero, meaning facial biometrics must be attempted even for infants, with standards equivalent to those used in a [photo] studio. '*Doing this at the border is not even remotely realistic.*'

Indeed, the implementing decision (EU) 2019/329 [65] defines the high requirements mentioned by the interviewees. Moreover, these requirements were discussed in 2020 during the eu-LISA 12th Industry Roundtable [66]. The interviewees explained that after the implementing decision was enacted, the EC organised a special session for the EU MSs, concluding that children's rights should be prioritised, and this gave documented interpretation on how to handle children in border control. '*It is not necessary to awaken young children during biometric data collection at border control points,*' despite the grammatical interpretation of the implementing decision mentioned above.

Five interviewees expressed **difficulties in interpreting the EU law either in the stage of drafting national legislation or during implementation of EU legal acts**. One interviewee brought an example: '*There is quite a lot hidden in one provision. It can be written in such a way that all parties understand completely differently what's behind it. And then you need to turn to the Commission again, get answers and then you wait and wait again, and that's where the time goes …*'.

Additionally, six interviewees from eleven indicated that **engaging stakeholders during legislative drafting process has been challenging**. The stages at which these challenges arose varied based on their specific assignments. Nevertheless, issues related to stakeholder engagement were noted during the negotiation of the EES and ETIAS draft regulations within the Council working group and similar difficulties were encountered later when the EC chaired the drafting of implementing acts at the SBC. Additionally, early stakeholder engagement presented challenges when drafting national legislation to comply with the EU law accurately. These challenges encompassed the timely identification and involvement of stakeholders, as well as insufficient proactive participation from certain actors. For example, Interviewee J explains the importance of national stakeholder engagement: '*Some implementation acts directly affect border control work. To think along and contribute [during legislative drafting], you need to know the [business] process; you need to know how the work "on the ground" is done or what technological solutions and possibilities are available, which would be the most rational from Estonia's perspective. How the [proposed] technical solution affects Estonia. Often a practical, hands-on implementation view was needed, not just a legal one.*'

While there was no documentation available to triangulate the concerns related to stakeholder engagement and difficulties in interpreting the EU law, the consistency of these challenges appearing across multiple interviews suggests a wider pattern of coordination strain, particularly during the initial planning stages.

## 5.3 Organisational challenges

To explore organisational challenges in the implementation of the EES and ETIAS, interviewees were asked to reflect on the role of institutional dynamics, coordination mechanisms, and stakeholder collaboration. The following questions guided this part of the interview:

- What role did organisational factors play in the implementation process? How were these factors addressed, if at all?
- In your view, were there any risks or uncertainties related to the implementation process? How were they managed or mitigated, if applicable?
- Can you share your thoughts on the collaboration and communication among the stakeholders involved? What worked well, and what could have been improved?
- How would you describe the coordination efforts between Estonian authorities and the eu-LISA during the development and/or implementation process?

Interviewees referred to several organisational-level challenges related to the development and implementation of the EES and ETIAS.

Firstly, five interviewees emphasised the **challenges related to establishing common priorities at national level** for all authorities involved in the development and implementation of the EES and ETIAS processes from the outset. Upon the enactment of the EU regulations, deficiencies in management-level coordination for priority-setting among the respective authorities were identified, along with a '*lack of ownership*'. Additionally, according to some interviewees no administrative resources were allocated, and the duties related to the development and implementation of the EES and ETIAS, which were about to commence, were considered as secondary tasks to primary duties. One interviewee highlighted the difficulty of engaging a person fully if it is not clearly stipulated who must handle the topic, who is responsible, who is part of the project, and that it is their designated job. Another interviewee confirmed the necessity of appointing

a responsible leader to unify all parties and emphasised: '*From an IT perspective, the cooperation of all parties is necessary to ensure that these EU-mandated developments are implemented with the appropriate priority. This isn't solely an IT issue, but it must be prioritised within the ministry's overall work plan and within the institution that represents the business side, indicating which IT solutions are actually required. Elevating this focus and ensuring mutual coordination among all institutions is crucial.*' However, views diverged among interviewees regarding who should set the priorities—those from the ministry level underscored that the EU regulations are directly applicable and thus the ministry should not assume a leading role, whereas interviewees from subordinated institutions (the PBGB, the SMIT) suggested that the responsibility for priority-setting lies with the ministry, which is tasked with strategic planning and the corresponding budgeting.

Secondly, several interviewees noted **weak co-operation among the EU MSs**. There was a lack of awareness regarding the progress of other EU MSs in their developments. Despite eu-LISA's chairmanship of the EES-ETIAS Advisory Group and formal working groups, organising various dedicated expert groups, such as the Informal Testing Expert Groups [67, p. 61], there was not an equally robust exchange of ideas and discussion of problems among the EU MSs themselves. Although all working group members possess each other's contact information, due to differing hierarchies representing the EU MSs, it is time-consuming to identify the appropriate person from another EU MS who faces a similar problem or who has successfully resolved it. Sharing experiences could be particularly relevant, as each EU MS has a slightly different perspective from which they approach solutions to the challenges presented.

A third challenge faced by the PBGB, was **the establishment of an ETIAS National Unit** as required by EU regulation 2018/1240 [8]. Extensive discussions occurred over several months to identify the optimal existing structural configuration into which the new unit could be integrated within the organisation's hierarchy. Furthermore, due to the postponed deadline for ETIAS implementation, maintaining the motivation of officials currently assigned to this unit has become increasingly complex.

The recurring challenges identified across multiple interviews, such as difficulties in determining priorities, in co-operation among EU MSs, and in establishing a new unit suggest a more profound issue within organisational framework, particularly during the

initial stages of development and implementing stages. Despite the shortage of documentary evidence, these challenges appear to be symptomatic of wider coordination strains.

## 5.4 Technical challenges

To investigate technical challenges related to the implementation of the EES and ETIAS, interviewees were asked to reflect on system development, integration processes, and technical dependencies. The interviewees were invited to address the following questions:

- What were the main technical considerations during the development and integration of the EES and ETIAS system in Estonia? Were there any specific factors that shaped the process?
- What role did the central system play in Estonia's timeline? Were there any dependencies or delays and how were they addressed?

The technical challenges reported by the interviewees can be categorised into three primary areas: (1) **the non-functionality or instability of central systems** (nine of the eleven interviewees); (2) **the absence, insufficiency or frequent updates of detailed technical interface documentation** (five of the eleven interviewees); and (3) **the unavailability of test environments** (four of the eleven interviewees).

One interviewee summarised the challenges the EU MSs faced during the years: '*All previous delays in the years 2021, 2022—these delays were, one could say, 100% because the central system was not in a condition to even consider going live. Not only were they not in a condition where the EU MSs could do their own tasks. The difficulties experienced in previous years have purely stemmed from the fact that constructing and stabilising the central system took much more time than anyone initially thought it would. Getting dozens of components to work together correctly—that's what took a lot of time and investigation. There were always some problems, some errors, some issues…*'.

According to one interviewee's explanation on both technical interface documentation inaccuracy and unavailability of test environment encapsulates this issue comprehensively: '*It is widely promoted that once the technical specification is completed, the eu-LISA considers that all the necessary prerequisites are in place for the EU MSs to start developing their own implementations. In practice, this means that if the*

*system is developed purely based on documentation, there is a 90% chance that things will be done incorrectly. … Because it is simply not possible to write down all the details at that moment. Every tiny detail is very important. We have even encountered situations where the central system is ready and everything should supposedly work. But the documentation and the central system functionality do not match one-to-one.*' Another interviewee elaborated that central technology for ETIAS underwent multiple revisions, necessitating EU Member States to reconsider and reanalyse their own developments accordingly.

The challenges associated with central system tests and testing environments are documented in the eu-LISA Annual Activity Report 2021, which notes that the EES central system application was delivered with a delay and exhibited instabilities during subsequent testing phases [61, pp. 25, 28, 145]. Furthermore, the eu-LISA Annual Activity Report 2022 details the frequency of updates to ETIAS interface control document, encompassing the encryption approach and European Search Portal specifications, which were disseminated to EU MSs on two occasions. Additionally, the final presentation of ETIAS software occurred for the fifth time. These instances illustrate the difficulties related to frequent updates of technical interface documentation. The same report also identifies ongoing issues with the availability of EES testing environments. Consequently, these complications led the eu-LISA Management Board to determine that the deployment deadline for the EES, initially set for mid-May 2023, could not be met, necessitating a postponement [67, pp. 41, 44].

The technical challenge highlighted by four interviewees of eleven concerned **the procurement of suitable technical equipment for the Estonian land border**. Two interviewees identified that the principal difficulties associated with implementing the EES in Estonia were related to devices for facial biometric data collection, which were custom-built for Estonian conditions. These devices had not previously been used at Estonian borders and were introduced due the implementation of the EES. One interviewee also highlighted the difficulties associated with capturing fingerprints in outdoor conditions, particularly during the colder months, which account for almost half the year in Estonia.

This challenge frequently overlapped with the descriptive code **'building infrastructure challenges'**, which described difficulties with installing the required equipment at

existing border crossing points as two interviewees comprehensively described. According to them, these difficulties were related to ensuring appropriate lighting conditions and the overall infrastructure of the land border crossing points having experienced challenges in accommodating the necessary equipment due to the lack of space.

The EC has emphasised the significance of biometrics in several documents. The 'Communication from the Commission to the European Parliament and the Council. Stronger and Smarter Information Systems for Border Security' states that 'Requests are mainly based on alphanumeric identity information though the exchange of biometric data is possible…' [5]. At the 2017 eu-LISA annual conference it was underscored that shared biometric system would increase flexibility as eu-LISA could focus its resources into operating a single biometric system rather than multiple systems [68, p. 33]. In 2018, during the first discussions of the draft implementing decision which established the specifications for the quality, resolution and use of fingerprints, and facial image for biometric verification and identification in the EES at the SBC meeting, EU MSs expressed concerns regarding the anticipated quality of facial images, due to technical challenges encountered at land borders and ferry ports when capturing images of travellers' in poor lighting conditions or within their vehicles. At the same SBC meeting the EC definitively stated that the EES biometric matching service (BMS) would be the cornerstone of the common biometric service making the quality of biometric data a pertinent issue [69]. In 2018, specific challenges related to land borders were outlined at the eu-LISA Industry Roundtable as the border crossing process must be adapted to local populations, infrastructure and threats and 'one and only solution' for all land border checkpoints is not available due the diversity of land border crossing points and relevant infrastructure [70, pp. 5, 10]. However, in 2019 the EC enacted implementing decision regarding the specifications for the quality, resolution, and usage of fingerprints and facial images for biometric verification and identification within the EES [65]. In 2020, during the eu-LISA Industry Roundtable, it was noted that image acquisition at land, water, and rail border crossing points could not always achieve the same quality as at airports [71, p. 10]. In 2022, discussions at the eu-LISA Industry Roundtable highlighted that smaller ports faced challenges in expanding their infrastructure to accommodate additional equipment required for the implementation of the EES, such as self-service kiosks and booths [29, p. 25]. A new technological solution, a full-automated (self-service)

checkpoint for Estonian citizens and residents possessing a biometric passport, was implemented at the Estonian southeastern border in 2023 [72].

During discussions regarding the challenges, the interviewees frequently elucidated **the complexities of developing the EES and ETIAS**, emphasising their **interconnection and dependencies on other national ISs** as well as on the **broader developments on large-scale EU ISs**. The interviewees detailed the situation pertaining to national IS developments as follows: '*The systems are interconnected, and if you change one, initially, you don't see the entire architectural picture of what else you need to modify*'; '*It was important that we could develop our existing information system in such a way that we didn't have to start everything from the scratch, but rather utilised what we already had and added new functionalities*'; '*Entry/Exit and ETIAS are just a part of the European Union projects. We also need to keep the big picture in mind to ensure that if a development is made somewhere that is necessary for everyone, all parties are aware*'; and '*EU information systems are not isolated entities; they affect many of our other information systems*'. Additionally, explanations were provided concerning the interdependencies of information systems at EU level: '*The approach was overly ambitious, with a very large scope encompassing various extensive projects developed simultaneously, with limited workforce on the eu-LISA side*'; '*With the EES central system, if even one member state isn't ready with their developments on time, no EU MS goes live. The risk of one EU MS is actually a risk for the entire project*'.

The eu-LISA Single Programming Document 2022-2024 has identified several substantial risks and challenges pertinent to the development of the EES and ETIAS. The document highlights the ambitious timeline for the delivery of these projects as a key concern, compounded by the instability of the legal base, which adds additional complexity to the support of all associated processes. Moreover, it notes that the evolution of the EES in 'parallel with its first period of operation, when issues following incidents might occur, increases the complexity of release management'. Regarding ETIAS, the document reports that the integration of components expected to be shared with the EES, along with numerous interoperability components, may introduce unforeseen delays. Consequently, the projected date for entry into operation is challenging due to the project's complexity and the necessity for seamless interoperability with multiple systems. Furthermore, the anticipated human resources allocated to these projects may prove insufficient [73, pp. 63–64, 66]. The multitude of simultaneous developments

scheduled for 2023-2027 are detailed in the eu-LISA Single Programming Document 2024-2026 (i.e. EES, VIS, interoperability components, to name the those that concern the current thesis) on a Gantt chart. However, the timeline presented on the chart is predicted on the EU Council decision from October 2023 [74, pp. 30–31], which does not account for the latest postponement of EES and ETIAS deployment to October 2025 [9]. The need to develop national ISs, such as the border control information system (PIKO) and the registry of residence and work permits, is specified in the explanatory note of the draft national legal act [64].

## 5.5 Contextual themes

The current sub-chapter addresses cross-cutting contextual factors related to delays and unfeasible timeframes, detailed and restrictive EU legislation, and the project-based funding approach to implementing the EES and ETIAS. These factors cannot be treated as standalone themes but rather influence how policy-related, legal, organisational and technical challenges are experienced or managed.

The first horizontal aspect related to legal, organisational, and technical challenges were general **delays and unfeasible timeframes**. Some interviewees (A, B, D, E) mentioned timing and delays to be an issue but several participants (C, F, G, H, J, K) expressed frustration with the scope of developments undertaken in the timeframe and its implications. One interviewee stated: '*The reality is that some processes take time and cannot be expedited. As a result, everything is constantly in the "red zone".*' Two interviewees emphasised that the biggest challenge was the uncertainty. Another interviewee specified technical challenges referring to the EES development: '*The biggest challenge is the uncertainty in this project. It's too much. Sometimes decisions must be made under the condition that we currently guess how this [system] might work.*' Third interviewee described the progress of ETIAS development similarly: '*Being constantly in a state of waiting, continuous re-planning, always operating in uncertainty*' and '*keeping the project [ETIAS] alive despite this*'. Another interviewee summarised the impact of delays from the technical implementation perspective for both systems: '*It's like a snowball effect: if one component is delayed, subsequent components are inevitably delayed, and this cascade of delays continues.*'

According to the documentation, the project schedule was discussed already in 2018 at the SBC meeting, where it was raised multiple times. It was noted that the project would continue 'as per high-level planning' [75]. Also commissioner's answers to Parliamentary questions clarify the issues faced with adhering to deadlines [10], [76]. The eu-LISA programming documents for three consecutive periods 2018-2020 [58, p. 163], 2019-2021 [59, p. 149] and 2021-2023 [60, p. 105] highlight challenges related to the EES and ETIAS projects as well. In highly aggregated form these challenges include potential delays in legal proposal approvals, dependencies between large projects, and technical difficulties. These issues led to serious delays and the postponement of the EES and ETIAS release [61, pp. 16, 24–26, 27–28, 145, 148].

Secondly, several interviewees highlighted **the detailed nature and restrictive provisions** in the EU legal acts—both the acts that regulate the implementation of the EES and ETIAS (discussed under sub-chapter 5.2 'Legal challenges') as well as those that regulate the use of EU funds as main instruments for implementing EU sector-specific policies [38]. One interviewee noted: '*From a financial perspective, these regulations impose highly restrictive conditions. For example, for the EES funding was granted under article 64* [7]*, and for ETIAS, under article 85(2)* [8]*. These provisions specify exactly how the funds can and cannot be used. This created a difficult situation because, for instance, project management costs could not be covered [with 100% EU support] from the top-up funds allocated by the EC [to the EU MSs]. Only development work and testing could be funded. However, associated costs had to be covered from other sources. To fulfil these conditions, we had to "divide" the projects fulfilling single goal into parts, with some funded at [regular] 75% and others at 100% of EU support [77]—making implementation extremely complicated.*' The opinion of the second interviewee is similar: '*Regarding the funding issue—this wasn't talked about much. Initially, it's unclear how much things will cost. There is no flexible funding model that considers whether deadlines change, or the content evolves. Often, some funding is available through EU funds for these projects, but this must be planned many years in advance, which is not feasible because development needs are not yet known. There should be more flexibility in this.*' The second interviewee also pointed to another aspect related to the restrictive funding between different policy areas of EU-wide ISs: '*Behind every information system there is basic infrastructure—servers. ... We don't set up a separate data centre for each system.*'

Third major concern that was brought out by interviewees C, D, F, G, H was related to **the project-based funding** that was affected by the constant postponement of the EES and ETIAS launch dates.

From the funding perspective, according to the information published on the website of the Estonian MoI, five separate projects were allocated with the EU funds for the implementation of the EES or ETIAS or both, during the period from 2019 to 2023 [78] and four separate projects are ongoing from 2023 to 2029 [79]. All these projects must be nationally budgeted and managed in a manner that ensures compliance (eligibility), both in terms of content and expenditure, with the separate legislation governing the use of the EU funds [80], [81], [82], [77].

As regards the implementation of the projects, the on interviewee highlighted: 'These projects change so much, the activities change so much, and often the activities do not even materialise within one project and move somewhere else—for example, to the next [period] EU fund' proceeding '… it wasn't possible to set project goals within the project's framework because they didn't align with reality'. The second interviewee describes: '*Unfortunately, these EU-level information systems, they have all been delayed. If you have planned to develop something by a certain time and find out you don't know when you will do it, it creates issues. For example, if we hire an external developer resource and have a contract signed, can we postpone or reschedule it? This is a problem.*' Third interviewee elaborated that if the launch date is postponed and the procurement agreement is terminated, in necessitates the initiation of a new public procurement process, the conclusion of a subsequent contract, and the beginning of work by new developers. The onboarding of these developers takes several months as they must familiarise themselves with the complexity of the EU and national level information systems involved in the development. Fourth interviewee expressed concern that project-based work cannot ensure continuity without dedicated resources.

While there was no public documentation available to triangulate interviewees' concerns about project implementation and the complexities of project-based funding, these issues were raised consistently across several interviews. Participants described how such challenges can lead to deviations from initially funded budgets, timelines and deliverables. These developments, according to interviewees, may increase the overall implementation costs and raise questions about the eligible use of the EU funds—

particularly in context of transitioning to a new EU multi-annual financial framework while the ISs are still under development.

## 5.6 Lessons learned

To identify lessons learned from the development and implementation of the EES and ETIAS, interviewees were invited to share reflective insights and forward-looking perspectives. The aim was to explore how past experiences, positive and negative, might inform future EU-wide large-scale IT projects. The following questions guided this part of the interview:

- Reflecting on the EES and ETIAS development and implementation process, what lessons or observations, if any, do you think are important to note?
- In your opinion, how can the experience from the EES and ETIAS development and implementation be applied to future EU-wide large-scale IT projects?
- Do you think future EU-wide projects could benefit from the EES and ETIAS implementation experience? If so, in what ways?
- What are your thoughts on the current collaboration and coordination between EU-level entities and Estonia? Are there any opportunities for improvement?

The lessons learned theme includes insights from participants regarding what they would approach differently in future large-scale IT system implementations. These lessons range from early stakeholder engagement and development practices to future suggestions regarding the EU large-scale ISs development. Unlike the challenge-based themes, the data coded under lessons learned revealed a broader range of insights that were best captured through two sub-themes: best practices and future suggestions.

Several interviewees (B, C, E, G, K) reflected that **earlier involvement of stakeholders** or the target group and wider communication at national level would have improved readiness for the development and implementation of the EES and ETIAS. Although this was not a publicly documented practice, it was mentioned repeatedly by several interviewees. For example, one interviewee suggested: '*Communication perspectives involve identifying target groups, finding the right people, and involving them from the very beginning.*' The similar view highlighting internal communication need, especially on involvement of top management, was expressed by second interviewee:

'*Communication must be initiated and must cover both the subordinated agencies and the management of the MoI to set priorities.*' The third interviewee described the importance of persistent messaging: '*You need to constantly present the project to different audiences… It was necessary to introduce what these EU projects are or what is the EES… You need to persistently promote it at every opportunity, you need to sell this. Because it's an unavoidable topic—it's an obligation.*' Moreover, the fourth interviewee pointed out the need for client engagement at the end-user level: '*Engage more with the client. Not just the primary users, but also those who actually perform border control, that is, those for whom we are developing—the end user.*' These accounts describe a recurring concern among interviewees regarding the extent and timing of communication with key actors.

Another lesson learned was noted by the interviewees from the technical development viewpoint. Interviewees emphasised the importance of **not basing development solely on technical documentation**. One interviewee described the situation as follows: '*Eu-LISA suggests that some things could be done simply based on documentation. We tried that a few years ago and saw that we would develop something and then redo it. Once the test environments were set up, it became apparent that developing based solely on documentation generally does not lead to the best outcomes, resulting in numerous revisions. In the past couple of years, we have not allowed it at all.*' This quotation reflects a broader concern among interviewees about the risks of relying heavily on technical documentation in place of testing environments.

In the following subsections the results on two sub-themes 'best practices', and 'future suggestions' are presented, which emerged during thematic analysis and provide notable insights to overall 'Lessons learned' sub-chapter.

### 5.6.1 Best practices

In this subsection, the practices perceived by the interviewees as best practices are described, highlighting their contributions to the development and implementation of the EES and ETIAS at both EU level and national level.

Regarding EU-level cooperation, about half of the interviewees appreciated eu-LISA's efforts in managing different advisory, expert groups, and sub-groups, and organising the meetings, including special sessions. Interviewees deemed **participation in eu-LISA's**

**working arrangements** essential for enabling information sharing and cross-national collaboration. One interviewee described such meetings as eu-LISA's long-standing practice, originating from earlier systems such as VIS and SIS. Similarly, the second interviewee, who participated in several groups simultaneously, found them useful for understanding the progress and challenges of other EU MSs. These perspectives are reflected in eu-LISA's Programming Document, which identifies the EES project management forum for national project managers as a critical success factor in promoting coordination across EU MSs [59, p. 148]. Despite this general appreciation, two interviewees expressed a preference for physical meetings over virtual ones, offering better communication outcomes on complex issues and stronger interpersonal engagement in face-to-face settings.

Concerning national level co-operation, despite the challenge of identification and involvement of stakeholders, the majority of interviewees (A, C, D, E, G, H, J, K) emphasised that a **setup of national project organisation** comprising all stakeholders from national institutions involved directly in the process was the best practice to facilitate mutual sharing of national information and insights from various EU-level committees, working groups, expert groups, and eu-LISA Management Board meetings. A cross-institutional mailing group was established, and regular network meetings are organised by the policy department advisor of the MoI to this day. It was pointed out by the interviewees that the network has retained its informal nature. The network's informal structure has allowed for adjustments to the group of attendees and topics discussed, aligning with the development of EES and ETIAS, and facilitating open dialogue on challenges faced by the participants.

One interviewee highlighted the challenge of aligning national project planning with both project-based funding cycles and eu-LISA's overarching timeline. To manage this dependency, the same interviewee proposed **keeping national project proposals deliberately flexible in terms of objectives and budgets**, in anticipation of delays caused by external circumstances. Furthermore, two interviewees recommended adopting a more **flexible approach to public procurement contracts**, which would support continuity in personnel and reduce the time required to onboard new developers. This emphasis on flexibility in the planning phase connects to the importance of structured risk management practices during implementation.

From a project management perspective, two interviewees emphasised the value of **mandatory risk assessments** process within the PBGB. They described it as a helpful tool for keeping project managers focused on the most critical aspects of implementation and for ensuring that mitigation measures could be put in place in a timely manner. Managing risks also intersects with the issue of personnel continuity, which emerged as a concern in several interviews.

A couple of interviewees emphasised the importance of maintaining **continuity in personnel** throughout the implementation of the EES and ETIAS. This concern applied both to national authorities and to external development teams hired through public procurement. Maintaining consistency was viewed as essential to preserving institutional knowledge and ensuring coherence throughout the ISs development process. This concern of sustainability also reflects a broader hesitation toward rushing development activities.

Before starting the development, two interviewees recommended **awaiting the finalisation of documentation and the availability of testing environments**. During the development of the EES, eu-LISA insisted that EU MSs proceed based on preliminary development documentation, which, according to interviewees, resulted in repeated revisions and additional costs in terms of both time and resources. This experience was described as a lesson that was later taken into account during the development of ETIAS. As one interviewee concisely remarked: '*Haste makes waste!*'

### 5.6.2 Future suggestions

When discussing lessons learned, some interviewees made suggestions on how future endeavours could benefit from the EES and ETIAS implementation experience.

The following observation from one interviewee offers a fitting introduction to this subsection: '*The European Union is not uniform in this matter. When a regulation is introduced, one must consider that while some EU MSs will manage the implementation adequately, others will encounter significant difficulties, impeding their ability to implement it within a reasonable timeframe, regardless of the amount of time allotted. This is the fundamental dilemma with any regulation, knowing that despite extended deadlines, certain states will continue to struggle. Conversely, some EU MSs will be able*

*to resolve the matter much faster.*' This comment reflects concerns over implications resulting from the **uneven implementation capacities** among EU MSs.

Nearly half on interviewees made suggestions on **refraining from too detailed EU regulation** that hinder the use of EU funds and stipulate the uniform live dates for EU large-scale information systems. The interviewees proposed that necessary flexibility for the use of EU funds should be foreseen, including possibility of shifting funds to subsequent years and from one EU financial framework to other. A few interviewees suggested that a budgetary reserve should be established also in national budgets to enhance flexible financing.

Three interviewees suggested that the challenges encountered during the development and implementation of ETIAS might encourage **the adoption of EU centralised information systems as a technically more rational alternative**. Moreover, one interviewee speculated that the model of centralised ISs could potentially extend to centralised procurement of equipment required for EU external border control, which could then be distributed to EU Member States according to their needs.

A couple of interviewees pointed out that **developing large-scale ISs should take place in consecutive order not all at once**. One interviewee suggested: '*it would be better to keep the scope smaller instead of burdening EU MSs with multiple large projects that have significant impact. One piece should be completed and then moved on to the next. For example, ETIAS is coming too soon after EES; it could have been done after finishing Entry-Exit.*' The same concern 'projects that were initially supposed to run in sequence will now have to be run in parallel' is expressed in the eu-Lisa Single Programming Document 2022-2024 where the insufficient staffing is discussed [73, p. 40]. This perception is connected to the recent amendment proposal to the respective EU legal acts [62], that some interviewees (C, E, F, I) highlighted. In this proposal the EC introduced a progressive rollout for the implementation of the EES system, as opposed to a full and simultaneous deployment in the EU MSs. This initiative was perceived positively, and two interviewees recommended that this **progressive approach should be adopted in future endeavours whenever feasible**. One interviewee described: '*The change in philosophy was to first develop the minimum requirements and then look at the rest piece by piece.*' Another interviewee noted that this modification might be interpreted as

incorporating agile development elements into the previously dominant waterfall development methodology.

Two interviewees suggested **more comprehensive preparation of EU legal acts** in the future involving all the stakeholders including organisations that are responsible for standardisation of biometric technology. According to the interviewees, allowing for a longer preparation period and more substantive inclusion of all stakeholders could contribute to higher-quality legislative proposals—both at the level of regulations and implementing acts—and help mitigate the risk of delaying the implementation of the ISs by three to four years. Additionally, one interviewee noted that the process of elaborating the implementing acts took longer than expected and suggested that **specific deadlines** for their proposal would have improved the legislative timeline.

One interviewee underscored the importance of clearly **defining the key phases of implementing EU-mandated ISs within national strategic documents** and the work programmes of the relevant institutions.

Despite the obstacles encountered during the development and implementation of the EES and ETIAS, a couple of interviewees identified **an overall enhancement in the knowledge base of border crossings** as a significant opportunity, given that Estonia previously possessed its own PIKO prior to the introduction of the EES. Nevertheless, the deployment of the EES and ETIAS enriches the information base further and facilitates information exchange with other EU MSs concerning the movement of third-country nationals in and out of the Schengen area.

# 6 Discussion

This chapter discusses the findings of this research in relation to the two main research questions outlined in the introduction chapter: how have Estonian authorities experienced the implementation of the EES and ETIAS and how this can inform the development of large-scale EU ISs in the future. It interprets the results presented in chapter 5 through the lens of theoretical framework presented in chapter 2 and reviewed literature introduced in chapter 3.

While the initial literature review focused on sources directly informing the theoretical and methodological framework of this study, certain additional works are referenced in this chapter to provide further context for the interpretation of the findings.

The chapter begins with answering the RQ2 of the current thesis: how have Estonian authorities experienced the implementation of the EES and ETIAS across policy, legal, organisational, and technical dimensions? Each dedicated sub-chapter answers the two sub-questions accordingly: what policy-related, legal, organisational, and technical challenges have influenced the process of implementing the EES and ETIAS in Estonia (SQ2.1) and what effects have these challenges had on the implementation process at national level (SQ2.2). The chapter ends with the lessons learned by the Estonian authorities, their best practices and suggestions for the future to answer the RQ1: how Estonia's experience with implementing the EES and ETIAS informs the development of large-scale EU ISs in the future?

## 6.1 Meta-themes: shapers of the challenges

The thematic analysis of interviews revealed three contextual themes—delays and unfeasible timeframes, detailed and restrictive EU legislation, and project-based funding—that systematically occur under all pre-defined main themes, namely policy-related, legal, organisational, and technical challenges of implementation of the EES and ETIAS, and shape how these challenges were experienced and how they impact the implementation process (figure 3). Due to their overarching nature and significance in

interpreting the results to provide a more comprehensive understanding of the implementation context, these can be referred to as meta-themes. A deeper inspection showed that meta-themes are most closely linked with EU level—its decision-making process, law-making, or practices in the implementation of the EU policies.

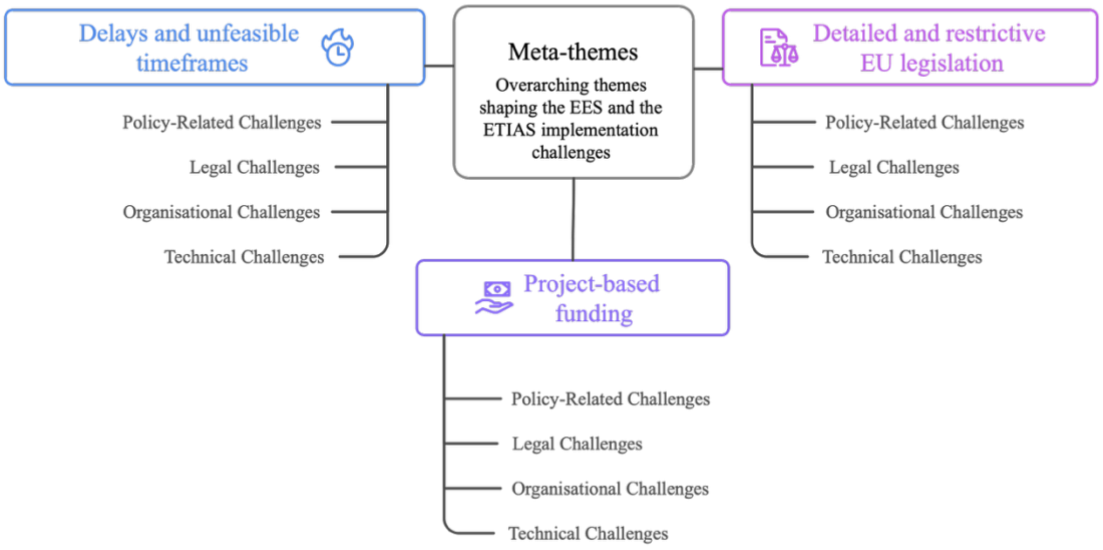


Figure 3. Meta-themes that shape the challenges of implementation of the EES and ETIAS.

### 6.1.1 Delays and unfeasible timeframes

The recurrent delays and unfeasible timeframes were frequently highlighted by interviewees when the main themes were discussed, ranging from the EU-level legislative drafting to the execution of development work and issues related to the availability of central systems. One interviewee characterised the implementation experience of the EES and ETIAS as a 'loop of delays.' This finding is consistent with previous research [44], [46] that have documented the postponements and delays associated with the SIS, another major EU information system. Interestingly, the EC asserts in the EES impact assessment that the VIS was delivered on time and within budget. Yet, in the subsequent sentence, the EC acknowledges that the VIS was introduced a year later than initially anticipated, attributing this delay 'to well-evaluated and duly accepted change due to its technical requirements' [35]. The European Commission appears to consider a one-year delay

permissible and timely, provided that adequate justifications are presented. This suggests that **deviations from the original schedules for large-scale EU information system developments are the norm rather than the exception**. A related issue—the influence of political urgency over technical realities—is further examined under policy-related challenges (sub-section 6.2.1).

### 6.1.2 Detailed and restrictive EU legislation

During the discussion of the main themes, the issue of detailed and restrictive EU legislation was often outlined. This encompassed legislation pertaining to both the EES and ETIAS, as well as legislation on EU funding. The overly specific and restrictive nature of the legislation impacted all main themes, apparent in policy-making, in the complexities of national law-making in a digitalised state such as Estonia, in the requirement to establish ETIAS National Unit [8] without IS readiness, in the use of biometric technology [65], and in the allocation of consistent EU funding for development work and personnel engagement.

Better Regulation Guidelines [83, pp. 9, 13–16] are relevant in this context. These guidelines define stakeholder consultation as 'a formal process, by which the Commission collects information and views from stakeholders about its policies', yet they do not provide for broad engagement during the initial stages of legal drafting. Evidence from the eu-LISA Industry Roundtable summaries [70, pp. 5, 10], [71, p. 10], [29, pp. 16–17] indicates that industry stakeholders raised concerns only after regulations and implementing decisions had already been adopted. Taken together, these perspectives suggest that **targeted and timely stakeholder involvement by the EC may enhance the quality and feasibility of the EU future legal acts**—an issue which appears underexplored in the current EC's procedural guidance.

The challenges related to mandatory creation of organisational units who fulfil the provisions foreseen in ETIAS regulation [8], are discussed under the subsequent sub-section 6.2.3. Furthermore, the possible explanation for the overly detailed nature of the technology related legislation, despite the risks of rigidity it introduced, could be that it was **an attempt to counteract the Collingridge dilemma** [84], wherein early-stage decisions about complex technologies are difficult to regulate effectively due to uncertainty, but later interventions become harder to implement as systems become entrenched. While this rationale was not articulated by interviewees nor explicitly stated

in the secondary source of data, it may offer a theoretical lens for understanding the pre-emptive legal detailing observed in the EES and ETIAS regulatory design. Although not part of the study's original theoretical framework, this concept helps to illustrate one possible rationale behind legislative choices specifying the use of technology.

### 6.1.3 Project-based funding as a tool

The project funding is the main instrument for implementing the EU policy [38]. It is worth noting that the interviews revealed that the definition of the *'project'* was differently understood by the interviewees. For some, the *'project'* started from the EC's legislative proposal: 'when a new project idea is introduced, it usually lands on the ministry's desk' and is closely related to the challenges of the involvement of all necessary stakeholders and priority-setting. However, for others the *'project'* started when the financial resources were allocated and the goals, activities, timeframe and budget were planned according to initial plans of the EES and ETIAS implementation. Also, the EES and ETIAS development was generally referred to as *'a project'*.

According to interviewees, the changes in project's goals, timeframes, and activities are frequent and due to the delays caused by the reality of development possibilities. Therefore, instead of a project serving as an effective and flexible approach [24], providing 'organisational clarity, order and control—thus strengthening the bureaucratic principles' [27], the transformation of its defining feature—temporariness—has turned the implementation of the EES and ETIAS from an intended middle-distance run into a bureaucratic marathon. 'Paradoxically, the bureaucratic organisation seems to tackle bureaucracy with more bureaucracy' as was found by Fred [27]. A potential solution might involve introducing project plasticity; however, according to Sydow et al. this approach requires further investigation [22].

These findings also suggest that while projects remain the primary implementation tool for EU policies, the current approach may benefit from a more coordinated review of legal and financial frameworks that underpin implementation. In particular, there appears to be a misalignment between the urgency of some policy objectives and the mechanisms provided for funding them. **A more flexible legal architecture—tuned to varying implementation rhythms across the EU MSs—could enhance the responsiveness and effectiveness of future initiatives.**

## 6.2 Challenges emerged and their effects

In this sub-chapter the challenges of all pre-defined main themes—policy-related, legal, organisational, and technical challenges—are discussed and analysed how these affected the implementation experience of the EES and ETIAS.

### 6.2.1 Policy-related challenges

The only policy related challenge identified in this study was the discrepancy between policy-related priorities (policymaking) and the implementation deadlines for the EES and ETIAS. This finding corresponds with meta-themes raised during interviews, in which persistent difficulties in meeting EU-imposed timeframes and dealing with delays were described. These challenges were attributed to the inherent complexity of ISs development processes, which cannot be accelerated, and to the tendency for delays to escalate once timelines begin to slip. This discrepancy was validated through both interview data and supporting documentation.

This finding underscores how **urgency at the political level can overshadow technical realities, creating significant organisational strain in aligning legislative drafting with implementation of ISs.** Clarke et al. [18], in their socio-technical analysis, similarly observed 'the dominance of political desires over rational management processes' and their observation aligns with the policy recommendations of Parkin [44], who, in a review of SIS related decision-making processes, warned against 'overambitious political timetables', arguing that they can undermine budgetary control and limit democratic and judicial scrutiny of new security technologies.

### 6.2.2 Legal challenges

In addition to the overly detailed and restrictive EU legal acts—discussed in previous subsection 6.1.2, which introduced overarching meta-themes—the implementation of EU regulations through domestic legislative processes was regarded by interviewees as a significant challenge. In addition to that, interviewees also reported challenges in interpreting EU regulation—both at the drafting stage and during later phases of application. These findings suggest that the complexity of EU legislation poses issues not only for compliance but also for consistent understanding. While the current study does not empirically confirm whether such challenges are systemic across EU MSs, similar concerns have been raised in literature. Although not included in the initial literature

review, Ferrod et al. [85] provide useful context for interpreting these results. Their research on the **application of deep learning techniques for dense legal text retrieval**, highlights the dual role such technologies could play: first, their proposed semantic search tool is designed to help identify differences in how EU laws are implemented at national level, and second, in supporting in interpreting domestic provisions in line with the EU law [85]. The fact that such tools are designed to aid both implementation and interpretation implies that difficulties in these areas may extend beyond isolated cases.

Another important legal challenge identified was the engagement of national stakeholders during the legislative drafting process at EU level. One interviewee explained that effective contribution to legal drafting requires not only legal expertise but also an understanding of corresponding business processes and technological capabilities. This observation suggests **the importance of comprehending the socio-technical systems approach to design an effective IS**, aligning with the recommendations made by Clarke et al. in their case study [18].

### 6.2.3 Organisational challenges

One interesting finding that emerged from the interviews—but is not addressed in the literature reviewed—is the absence of a common national-level mechanism for priority-setting among involved authorities. While each institution was responsible for its mandate and scope of the implementation, no unified framework appeared to exist for coherent cross-agency priority setting before EU regulations entered into force. This finding highlights a governance-level gap that contributed also to legal challenges revealing stakeholder engagement issues and thus affected the smooth start of the national development process. This dynamic reflects what Munck af Rosenschöld [25] has noted about difficulty of aligning project-level actions with high-level political strategies: **when political goals are overly general, they provide limited guidance for operational coordination**. In this case, the strategic urgency to meet EU deadlines was not matched with corresponding national strategy for setting and aligning internal priorities—illustrating a misalignment between political direction and administrative capability [25].

Another situation revealed by this study illustrates a broader issue in project-based implementation models; namely, that funding assumptions tied to system activation may not hold when delays occur. Several interviewees described the challenges involved in establishing the ETIAS National Unit, including delays related to assigning its

institutional position and clarifying its operational hierarchy. While the unit is now in place, the postponement of ETIAS deployment has left the unit on the *continuum* of preparatory tasks without the IS to support its work. Notably, although the interviewees did not raise financial concerns, the unit is currently maintained using project-based funding [79], pending the launch of ETIAS that would generate its operational revenue through travel authorisation fees, as foreseen in the EU regulation [8]. This challenge highlights **a structural vulnerability in relying on tightly sequenced planning and funding approach**, reinforcing the aspects already revealed under the project-based funding meta-theme in the previous subsection 6.1.2.

An additional observation concerns the desire expressed by interviewees for **horizontal communication between EU MSs during implementation of the EES** although formal EU policy documents and other public data reviewed in this study do not explicitly promote such collaboration. This suggests that national implementers are seeking informal learning networks or shared platforms to cope with complexity—an insight that resonates with previous research on IT project success factors [42]. The absence of institutionalised support for this communication could represent a missed opportunity for collective problem-solving.

### 6.2.4 Technical challenges

The interviews underscored a strong dependency on eu-LISA, the EU agency responsible for the development of the central systems for the EES and ETIAS. Repeated and prominent references highlighted significant challenges arising from eu-LISA's timelines for central system development, delays in the preparation and dissemination of technical documentation to EU MSs and failures to provide testing environments to EU MSs. These challenges contain the issues outlined in the meta-theme concerning delays and unfeasible deadlines discussed under the previous sub-section 6.1.1. Furthermore, this discrepancy aligns closely with policy-related challenges (the previous sub-section 6.2.1), highlighting how **the urgency at the policy level often surpass technical realities** that has been reflected also in previous research of Clarke et al. [18] and Parkin [44].

In addition to the development issues associated with the EES and ETIAS, challenges were reflected in procuring appropriate hardware components, which consider the specific physical infrastructure of the Estonia's EU external border and Estonia's climatic

conditions. These practical insights given by the interviewees describing real-world technological and infrastructural constraints are seldom discussed in the literature on EU large-scale ISs. Nevertheless, these challenges lead to an issue that was rarely mentioned in the interviews due to the research's primary focus on the EES' and ETIAS' development and implementation—maintenance costs. Glouftsios' [45] study, which focused on the maintenance of EU large-scale information systems such as SIS II and VIS, highlights **the critical importance of maintenance efforts to ensure the functionality and sustainability of systems and infrastructures**, preventing breakdowns and enabling continuous operation [45]. Although Glouftsios' analysis concentrated on different systems, the same principle applies to the EES and ETIAS. This crucial element of ensuring functionality and sustainability returns to the overarching meta-theme—project-based funding (the previous sub-section 6.1.3)—and the concern that such funding models may not be a sustainable financing model to guarantee well-maintained ISs in the future.

Another significant outcome relates to the interconnection and dependencies of the EES and ETIAS on other EU large-scale information systems as well as national ISs. This complexity relates also to the meta theme of detailed and restrictive EU legislation (the previous sub-section 6.1.2) and legal challenges reflected under the previous sub-section 6.2.2. The approach taken to the development of the EES and ETIAS was evaluated to be overambitious and extensive due to the execution of other EU large-scale ISs' developments in parallel. This overambitious practice was also verified via the eu-LISA Programming Document [74, pp. 30–31]. Applying such practice could have been inevitable due to **the influence of political urgency over technical realities** that was discussed under the previous sub-section on policy-related challenges (the previous sub-section 6.2.1) but the research of Draheim et al. [32] gives another angle to this issue. They [32] analysed the principal narratives and discourses applicable to digital government, noting that the tech-savvy narrative frequently emphasises a focus on technology and a positive outlook. They state that this perspective may occasionally neglect the systemic nature of e-government, particularly concerning disruptive technologies. The argument that IT technology is accessible and should be utilised to transform public administration or the whole society is among the most prevalent in the tech-savvy narrative [32]. Concerning the current study, the author claims that the EC's communication [5] has predominantly relied on **tech-savvy arguments** when referencing

the utilisation of different EU ISs to achieve the objectives of enhancing external border management as well as internal security of the EU.

## 6.3 Lessons learned and institutional reflections

The next sections detailed the challenges experienced by Estonian public authorities in the development and implementation of the EES and ETIAS. These challenges are demonstrated in the context of their impact on the national-level processes. The succeeding sections offer an overview of the lessons learned and best practices adopted by Estonian authorities, alongside recommendations for future endeavours. Consequently, the guidelines presented herein aim to serve as best practice principles for the national implementation of EU large-scale information systems.

### 6.3.1 Best practices

In the development and implementation of the EES and ETIAS several best practices emerged from interviews with Estonian authorities. These practices are instrumental at both the EU and national levels.

At the EU level, eu-LISA's efforts in managing **advisory and expert groups** were highly appreciated. **Participation at these meetings** facilitated information sharing and cross-national collaboration, which were essential for the success of the development and implementation of the EES and ETIAS. Despite the general appreciation for virtual meetings, some interviewees preferred physical meetings for more effective communication on complex issues and stronger interpersonal engagement.

At the national level, **the establishment of a national project organisation comprising all stakeholders** was deemed the best practice. This setup facilitated mutual sharing of national information and insights from various EU-level committees and meetings. The informal nature of the network allowed for adjustments to the group of attendees and topics discussed, aligning with the development of the EES and ETIAS.

Both of these reflections are linked to the core component of the theory of temporary organisations, which is the team [22]. Since the transition to the new ISs occurs as a result of the joint effort of the entire team, and in the implementation of the EES and ETIAS, both eu-LISA teams and the teams of the EU MSs form a common team. To achieve the

best results in development and implementation of ISs, the interaction within national team and its interaction and networking with eu-LISAs and other EU MSs teams must be encouraged. The communication was also deemed one of the key factors of IT projects success in the previous study of Iriarte and Bayona [42].

**Maintaining continuity of staffing** was emphasised as essential for preserving institutional knowledge and ensuring coherence throughout the development process. The prioritisation of staffing continuity by some interviewees aligns with broader findings in the literature, which underscore the alignment of personnel as a key determinant of IT project success [42]. Notably, while Estonia's context appeared relatively stable, challenges at EU level (e.g. within eu-LISA [17]) reveal the wider vulnerability of cross-border projects to personnel discontinuity. Eu-LISA has suffered from staffing shortages, rendering the agency reliant on external service providers [73, p. 40]. Despite the challenges associated with sustaining the funding of the external development contracts due to project-based funding, Estonia's low staff turnover and existing development resource contracts have significantly mitigated the development and implementation challenges.

**Flexibility in national project planning and public procurement contracts** was outlined to manage dependencies and ensure continuity of outsourced personnel. This approach was supported by structured risk management practices during implementation. **Mandatory risk assessments** were deemed necessary to keep project managers focused on critical aspects and ensuring timely mitigation measures. From the preceding experience with the EES development already during the development of ETIAS, the practice was introduced to await the finalisation of technical documentation and the availability of central system and testing environments by eu-LISA before starting development to avoid repeated revisions and additional costs.

These practices align closely with insights from temporary organisations theory, which emphasises the need for flexible structures, adaptive planning, and proactive risk management in time-bound, resource-limited projects [24]. It can be deducted that flexible public procurement contracts and decision to await finalised technical documentation from the eu-LISA before starting national development work are reflective efforts to manage uncertainty and minimise resource waste in a volatile development and implementation environment. Mandatory risk assessment similarly

demonstrates how temporary project seeks for anticipatory governance to enhance stability and control.

### 6.3.2 Future suggestions

The interviewees shared valuable insights on how future endeavours could benefit from the implementation experiences of the EES and ETIAS.

As a reflection to detailed and restrictive EU legislation, discussed in sub-section 6.1.2 as one of the meta-themes, several interviewees suggested **avoiding overly detailed EU regulations that regulate the implementation of the EU ISs and specifically those that hinder the use of EU funds**. Also, they proposed flexibility in shifting funds to subsequent years and establishing budgetary reserves in national budgets.

Perhaps the most interesting proposal next to the recommendation of adopting EU centralised information systems as a technically rational alternative, was **the proposal to analyse the potential to extend this practice also to centralised procurement of equipment for EU external border control**.

The importance of developing large-scale ISs in consecutive order rather than simultaneously was emphasised, suggesting completing one IS before moving on to the next development. This perception is connected to the recent amendment proposal for a **progressive rollout** of the EES system [62], which was positively received and **recommended for future endeavours whenever feasible**.

Allowing for **a longer preparation period for preparing legislative proposals by the EC** could contribute to higher quality of legal documents. It was suggested to engage all stakeholders in the preparation of EU legal acts—those who represent the users of the ISs, technology providers, as well as representatives of those organisations whose businesses are affected by the planned change (in case of the EES and ETIAS those were carriers)—rather than involving and informing them after the legislation is enforced. Also **setting specific deadlines to the EC for elaboration of implementing acts** was one of the suggestions that could speed up the legislative process.

Regarding national perspective, **clear definition of the key phases of implementing EU-mandated ISs within national strategic documents and work programs** was also underscored.

These suggestions not only reflect practical experiences but also highlight underlying tensions identified in socio-technical systems theory. The call for more flexible legislative and funding frameworks underscores the challenge of aligning fast-evolving technical needs with rigid political and legal processes, a core concern in socio-technical system implementation [15]. Similarly, recommendations to phase IS developments sequentially at the EU level and to anchor key implementation phases in national strategic planning both illustrate the resource and time limitations that temporary organisations i.e. projects face when managing large-scale, externally mandated projects, but seek the mechanism linking them to permanent organisation [24]. Greater early involvement of technical stakeholders in legislative drafting reflects a recognition that more integrated socio-technical alignment at the design stage could mitigate long-term implementation challenges. This corresponds to the suggestion of Zwikael and Gil-Garcia on exhaustive preparation before initiating complex projects [40].

### 6.3.3 Good practice recommendations

In conclusion, the following Table 2 presents a research-based 'Good practice recommendation' for the practitioners at national-level regarding the development and implementation of large-scale EU ISs, derived from the conducted interviews.

Table 2. Good practice recommendations

| No. | Recommendation | When to apply |
|---|---|---|
| 1 | **Identify all stakeholders at the** different levels (policy-making, public service delivery, development of ISs and technical infrastructure, users of the ISs). | Should be applied after the EC has issued a proposal for a new legal act related to EU large-scale IS, and the proposal has been assigned within the organisation. |
| 2 | **Identify all the national ISs** that are potentially dependent of the planned change **and authorities** using their data. Expand and refine the list set out in point 1. | |
| 3 | **Ensure the early engagement of all stakeholders** in order to contribute to the highest possible quality of legislation both at the EU and national level and ensure prompt start of preparatory work. | Should be applied once negotiations or consultations regarding the new legal act have begun and should be revisited periodically throughout the negotiation or consultation process. |
| 4 | **Establish a cross-agency national coordination platform early**, including all stakeholders to enhance information exchange. | |

| | | |
|---|---|---|
| 5 | **Clarify institutional mandate for the implementation of each part of the EU legal act.** Pay particular attention to organisational changes resulting from the legislation. | |
| 6 | **Promote proactive communication with the EC and EU agencies** to align interpretations of technical and legal requirements. | |
| 7 | **Anticipate regulatory rigidity from EU level** and develop internal strategies to deal with this by negotiating for more flexibility at national level (incl. public procurement procedures and contracts). | Should be applied as the final stage of negotiations or consultations approaches, and prior to discussion on national budgets for the following years; it should then be revisited annually until the legal act in question is fully implemented. |
| 8 | **Build and negotiate flexible project plans** that can absorb timeline and priority changes imposed by the EU-level policy change and technical developments. | |
| 9 | **Plan for temporary funding gaps**, especially when operational budgets depend on the EU funding or IS-generated revenues. | |
| 10 | **Evaluate the risks regularly and document the best practices, and unexpected challenges continuously** for future institutional learning. | Should be applied as an ongoing process until the legal act in question is fully implemented. |

# 7 Limitations and future work

This chapter summarises the limitations encountered in this study and proposes directions for future research. It presents the constraints specific to Estonian context and emphasises how the research findings can underpin broader discussions and developments in the field.

## 7.1 Limitations

While Estonia offers a valuable case due to its strong digital infrastructure and centralised coordination capacity, these same features may limit the transferability of certain findings to other EU MSs.

For example, due to the relatively centralised nature of Estonian public administration, all the authorities directly involved in the EES and ETIAS implementation (the PBGB, the SMIT) are subordinated by the MoI. While other EU MSs may have many entities dealing with the EES and ETIAS, in Estonia the biggest stakeholder is the PBGB responsible for border guard and migration as well as police matters.

Furthermore, some technical lessons learned may reflect Estonia's relatively small administrative scale and digital maturity, which are not shared across all EU MSs and that was outlined also during interviews. In Estonia the necessary integrated ISs were in place when the development of the EES started and it raised specific legal and technical challenges that may not be present in other EU MSs.

This study is based on qualitative interviews with Estonian stakeholders involved in the implementation of EU-wide ISs and publicly available documentation. Only the publicly available summaries of the SBC meetings were used for triangulation and the ones that were not publicly available were requested from the EC in February 2025. This request was first extended and then exceeded its time limit by the deadline to submitting the current thesis. The publicly unavailable documentation could have given more in-depth insights on EU legislative process and the issues raised both by the EU MSs and the eu-LISA.

As such, the findings should be interpreted with the above-mentioned contextual lens in mind.

## 7.2 Future research directions

Further research could go more in-depth and use comparative approaches to explore whether similar challenges and practices appeared in the development and implementation of the EES and ETIAS in other EU MSs with different institutional or technical starting points.

The present master's thesis addresses the topic of interoperability—a framework, a software layer that would interlink the ISs in the EU Justice and Home Affairs area—only briefly, as it is based on a different legal framework from that of the EES and ETIAS. A more in-depth examination of this subject and its implications could serve as the basis for future research.

Future research could explore also the evolution of service provision (business processes) related to the implementation of the EES. As regards the ETIAS, the further research could be particularly interesting from the point of view of launching a new EU-wide e-service for third country nationals—the travel authorisation.

# 8 Conclusion

The implementation of large-scale information systems within the EU, specifically the EES and the ETIAS, presents a complex and multifaceted challenge. This thesis has explored the Estonian case, highlighting the various policy-related, legal, organisational, and technical hurdles encountered during the development and implementation phases.

From the outset, the ambitious timelines set by political priorities often overshadowed the technical realities, leading to recurrent delays and unfeasible deadlines. These delays were compounded by the detailed and restrictive nature of the EU legislation, which posed significant challenges for national-level implementation. The complexity of interpreting and applying the EU regulations further intensified these issues, underscoring the need for more flexible and adaptive legal frameworks.

Organisationally, the absence of a common national-level mechanism for priority-setting among involved authorities revealed a governance-level gap that hindered smooth coordination and stakeholder engagement at the beginning. The establishment of the ETIAS National Unit, despite its operational readiness, faced challenges due to the postponed launch dates, highlighting the structural vulnerability of relying on tightly sequenced planning and funding approaches.

Technically, the dependency on the eu-LISA for the development of central systems, coupled with the challenges of procuring appropriate hardware components suitable for Estonia's conditions, underscored the practical limitations of implementing such systems. The interconnection and dependencies of the EES and ETIAS on other EU large-scale ISs and national ISs further complicated the development process.

Despite these challenges, several best practices emerged from the Estonian experience. The efforts of eu-LISA in managing advisory and expert groups facilitated cross-national collaboration and information sharing. At the national level, the establishment of a cross-agency coordination platform and the emphasis on maintaining continuity of staffing were instrumental in mitigating development and implementation challenges. Flexibility in project planning and public procurement contracts, along with structured risk

management practices, proved essential in managing dependencies and ensuring continuity.

Looking forward, the lessons learned from the implementation of the EES and ETIAS offer valuable insights for future endeavours. Avoiding overly detailed EU regulations, adopting a progressive rollout approach, and engaging all stakeholders early in the legislative drafting process are crucial steps to enhance the quality and feasibility of future large-scale ISs. Additionally, developing ISs in consecutive order rather than simultaneously and analysing the potential for centralising procurement of equipment for EU external border control could further streamline the implementation process.

In conclusion, the Estonian case of implementing the EES and ETIAS highlights the intricate interplay between policy-related priorities, legal frameworks, organisational coordination, and technical realities. By addressing these challenges and adopting best practices, future large-scale ISs within the EU can be developed and implemented more effectively, ensuring better resource allocation, stakeholder coordination, and technical feasibility.

This thesis aimed to answer two main research questions:

1. How can Estonia's experience with implementing the EES and ETIAS inform the development of large-scale EU ISs in the future?
2. How have Estonian authorities experienced the implementation of the EES and ETIAS across policy, legal, organisational, and technical dimensions?

Additionally, this thesis addressed two sub-questions:

2.1. What policy-related, legal, organisational and technical challenges have influenced the process of implementing the EES and the ETIAS in Estonia?

2.2. What effects, if any, have these challenges had on the implementation process at national level?

The findings presented in this thesis provide clear answers to both main research questions and their sub-questions. Estonia's experience with implementing the EES and ETIAS have revealed a range of challenges and best practices, offering actionable insights for the development of future large-scale EU ISs (RQ1). Through a detailed examination of policy-related, legal, organisational, and technical dimensions, the study has captured

how Estonian authorities experienced the implementation process (RQ2), while also identifying the specific challenges (SQ2.1) and their effects at national level (SQ2.2).

By addressing these findings, the thesis contributes to institutional learning that may inform future endeavours and support improved resource allocation, stakeholder coordination, and technical feasibility.

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# Appendix 1—Plain licence for allowing the thesis to be available and reproductible for the public

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# Appendix 2—Interview questionnaire in English

Questions to the participant of the interviewee:

| | |
|---|---|
| **General background** | |
| 1. How would you describe your role and involvement in the EES and ETIAS implementation process?<br>2. Can you describe the involvement of the EU or national institutions and other stakeholders in the implementation process? How would you characterise your authority's interactions with them? | |
| **Challenges in implementation** | |
| Policy-related challenges | 3. Can you describe how policy-related considerations influenced the development and implementation of the EES and ETIAS in Estonia? Were there any significant challenges or opportunities that emerged, and how were they managed?<br>4. How did the requirements set by the EU level legal framework shape Estonia's approach to the activities undertaken? |
| Legal challenges | 5. How did Estonia's existing legal framework influence the implementation of the EES and ETIAS? Were there any specific aspects that required adaptation or posed challenges?<br>6. In your experience, were there any notable considerations or obstacles in aligning the EES and ETIAS with Estonia's legal requirements? How were these addressed, if applicable? |
| Organi-sational challenges | 7. What role did organisational factors play in the implementation process? How were these factors addressed, if at all?<br>8. In your view, were there any risks or uncertainties related to the implementation process? How were they managed or mitigated, if applicable?<br>9. Can you share your thoughts on the collaboration and communication among the stakeholders involved? What worked well, and what could have been improved?<br>10. How would you describe the coordination efforts between Estonian authorities and the eu-LISA during the development and/or implementation process? |
| Technical challenges | 11. What were the main technical considerations during the development and integration of the EES and ETIAS system in Estonia? Were there any specific factors that shaped the process? |

| | |
|---|---|
| | 12. What role did the central system play in Estonia's timeline? Were there any dependencies or delays and how were they addressed? |
| **Impact and outcomes** | |
| 13. Reflecting on the EES and ETIAS development and implementation process, what lessons or observations, if any, do you think are important to note?<br>14. In your opinion, how can the experience from the EES and ETIAS development and implementation be applied to future EU-wide large-scale IT projects?<br>15. Do you think future EU-wide projects could benefit from the EES and ETIAS implementation experience? If so, in what ways?<br>16. What are your thoughts on the current collaboration and coordination between EU-level entities and Estonia? Are there any opportunities for improvement? | |
| **Conclusion** | |
| 17. Is there anything else you would like to share or elaborate on that we haven't covered in this interview? | |
| **Additional data resource** | |
| 18. Is there anyone else you would recommend I speak with to gain further insights into the development and implementation of the EES and ETIAS? | |

# Appendix 3—Interview questionnaire in Estonian

| | |
|---|---|
| **Üldine taust** | |
| 1. Kuidas kirjeldaksite oma rolli ja kaasatust EESi ja ETIASe rakendamise protsessis?<br>2. Kuidas kirjeldaksite EL-i või riiklike asutuste ja teiste huvirühmade kaasatust rakendamise protssessis? Kuidas iseloomustaksite oma asutuse suhtlust nendega? | |
| **Rakendamise väljakutsed** | |
| Poliitika-kujundamisega seotud väljakutsed | 3. Kuidas mõjutasid poliitikakujundamisega soetud kaalutlused EESi ja ETIASe arendamist ja rakendamist EEsti? Kas esines olulisi väljakutseid või võimalusi ja kuidas nendega toime tuldi?<br>4. Kuidas kujundasid EL-i õigusraamistiku nõuded Eesti lähenemist ettevõetud tegevustele? |
| Õiguslikud väljakutsed | 5. Kuidas mõjutas Eesti olemasolev õigusraamistik EESi ja ETIASe rakendamist? Kas oli konkreetseid aspekte, mis nõudsid kohandamist või kujutasid endast väljakutset?<br>6. Teie kogemuse põhjal — kas EESi ja ETIASe vastavusse viimisel Eesti õigusega ilmnes märkimisväärseid kaalutlusi või takistusi? Kuidas neid vajadusel lahendati? |
| Organisat-sioonilised väljakutsed | 7. Millist rolli mängisid organisatsioonilised tegurid rakendamise protsessis? Kuidas neid tegureid käsitleti, kui üldse?<br>8. Teie arvates, kas rakendamise protsessiga kaasnes riske või ebakindlust? Kuidas neid vajadusel juhiti või leevendati?<br>9. Kuidas kirjeldaksite hüvirühmade vahelist koostööd ja suhtlust? Mis toimis hästi ja mida oleks saanud paremini teha?<br>10. Kuidas kirjeldaksite Eesti asutuste koostööd eu-LISAga arendus- ja/või rakendamisprotsessi käigus. |
| Tehnilised väljakutsed | 11. Millised olid EESi ja ETIASe süsteemide arendamisel ja integreerimisel peamised tehnilised väljakutsed Eestis? Kas olid konkreetsed tegurid, mis protsessi mõjutasid?<br>12. Millist rolli mängis keskne süsteem Eesti ajakava kujundamisel? Kas esines sõltuvusi või viitusi ning kuidas neid lahendati? |
| **Mõju ja tulemused** | |
| 13. Milliseid õppetunde või tähelepanekuid peate oluliseks esile tõsta EESi ja ETIASe arendamise ja rakendamise protsessist lähtuvalt? | |

| |
|---|
| 14. Kuidas saaks teie arvates EESi ja ETIASe arendamise ja rakendamise kogemust kasutada tulevaste EL-i üleste suuremahuliste IT-projektide puhul?<br>15. Kas teie hinnangul võiksid tulevased EL-i projektid saada kasu EESi ja ETIASe rakedamise kogemusest? Kui jah, siis mil viisil?<br>16. Mida arvate praegusest koostööst ja koordineerimisest EL-i tasandi üksuste ja Eesti vahel? Kas näete parandamisvõimalusi? |
| **Kokkuvõte** |
| 17. Kas on veel midagi, mida sooviksite jagada või täpsustada, mida me selles intervjuus ei käsitlenud? |
| **Täiendav andmeallikas** |
| 18. Kas oskate soovitada kedagi teist, kellega võiksin rääkida, et saada täiendavat teavet EESi ja ETIASe arendamise ja rakendamise kohta? |

# Appendix 4—Thematic coding map of the interview analysis

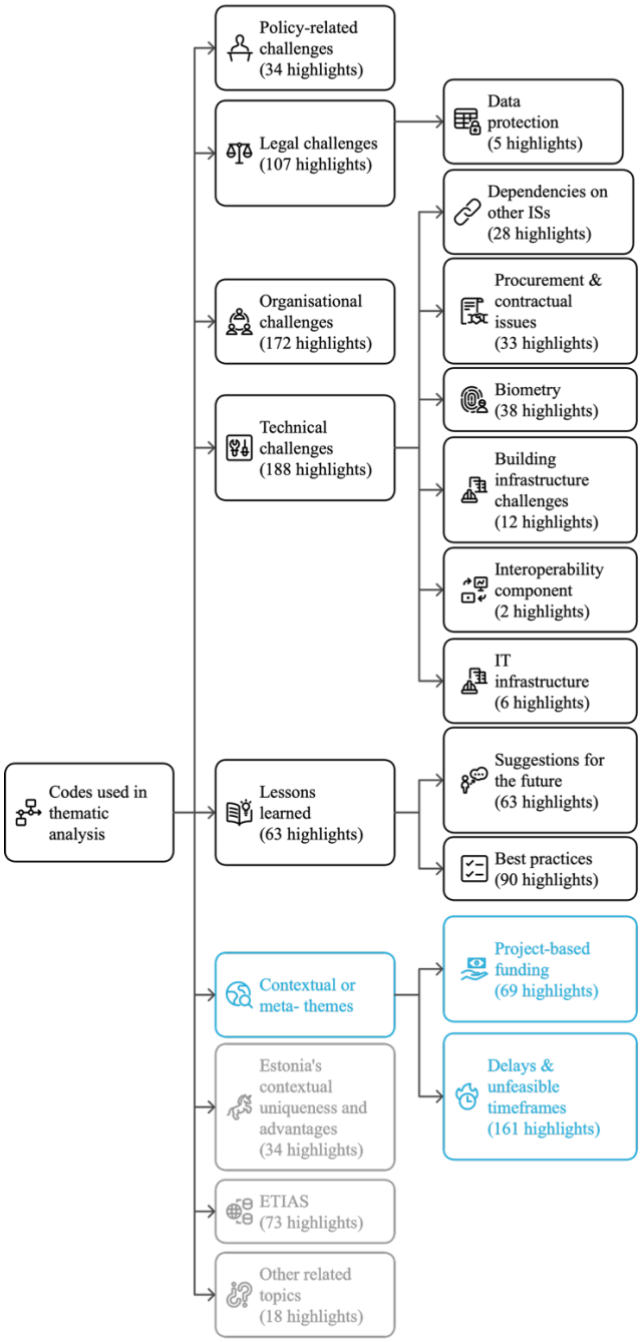


Figure 4. Thematic coding map of the interview analysis