SCHOOL OF COMPUTATION, INFORMATION AND TECHNOLOGY - INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Bachelor's Thesis in Informatics

# Collecting Feedback on Design Patterns for Platform Engineering in the Public Sector

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# Sammlung von Feedback zu Designmustern für das Engineering von Plattformen im öffentlichen Sektor

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I confirm that this bachelor's thesis in informatics is my own work and I have documented all sources and material used.

Munich, 15.03.2023 Dmytro Voitsekhivskyi

# Acknowledgments

I would like to express my sincere gratitude to all those who have supported me throughout the completion of this thesis.

Firstly, I would like to extend my thanks to my supervisor, Prof. Dr. Florian Matthes, for allowing me to do the thesis in business informatics, despite my pure computer science course and believing that I would've managed it from the very beginning.

I am also indebted to my advisor, Peter Kuhn, whose unwavering support and encouragement have been instrumental in the successful completion of this project. His expert guidance, timely advice, and regular meetings have provided me with the necessary direction and structure to accomplish my goals.

I would also like to acknowledge the support of my family, who have been a constant source of motivation and inspiration. Their love and unwavering belief in me have encouraged me to persevere through the challenges and obstacles encountered during this journey.

Finally, I would like to extend my gratitude to all the participants who generously gave their time and contributed to this study. Their insights and responses were invaluable in achieving the research objectives.

Once again, thank you to everyone who has contributed to the successful completion of this thesis.

# Abstract

The concept of Government as a Platform (GaaP) has the potential to transform the public sector by providing an open platform for collaboration between citizens and government. However, most existing infrastructures in the public sector are silo-based, which can be addressed through platformisation. Despite the benefits of a platform-oriented infrastructure, such as component reuse and standardisation, there are currently no clear guidelines or methods for the transformation process towards platform-oriented infrastructure. Nonetheless, some countries have managed to implement the GaaP concept successfully, and their experiences can be used to identify common patterns that can be reused. To this end, this thesis aims to develop an advanced set of patterns and collect and refine feedback on existing design patterns for engineering in the public sector by examining the practical experiences of successful GaaP countries. After reviewing the literature and analyzing national reports and institutional websites, we focus on interviews with Estonia, the UK, and Italy, which have made significant progress in implementing the platform model. By filtering, sorting, and generalizing the design decisions made by these countries, we identify the underlying design patterns that can serve as general GaaP principles for guiding the application of the platform approach in other countries.

# Kurzfassung

Das Konzept "Government as a Platform"(GaaP) hat das Potenzial, den öffentlichen Sektor zu verändern, indem es eine offene Plattform für die Zusammenarbeit zwischen Bürgern und Behörden bietet. Die meisten bestehenden Infrastrukturen im öffentlichen Sektor sind jedoch silobasiert, was durch eine Plattformisierung behoben werden kann. Trotz der Vorteile einer plattformorientierten Infrastruktur, wie die Wiederverwendung von Komponenten und die Standardisierung, gibt es derzeit keine klaren Leitlinien oder Methoden für den Umwandlungsprozess hin zu einer plattformorientierten Infrastruktur. Nichtsdestotrotz ist es einigen Ländern gelungen, das GaaP-Konzept erfolgreich umzusetzen, und ihre Erfahrungen können genutzt werden, um gemeinsame Designmustern zu identifizieren, die wiederverwendet werden können. Zu diesem Zweck zielt diese Arbeit darauf ab, einen fortgeschrittenen Satz von Designmustern zu entwickeln und Rückmeldungen zu bestehenden Entwurfsmustern für das Engineering im öffentlichen Sektor zu sammeln und zu verfeinern, indem die praktischen Erfahrungen erfolgreicher GaaP-Länder untersucht werden. Nach der Durchsicht der Literatur und der Analyse nationaler Berichte und institutioneller Websites konzentrieren wir uns auf Interviews mit Estland, dem UK und Italien, die bei der Umsetzung des Plattformmodells erhebliche Fortschritte gemacht haben. Durch Filtern, Sortieren und Verallgemeinern der von diesen Ländern getroffenen Designentscheidungen identifizieren wir die zugrunde liegenden Designmuster, die als allgemeine GaaP-Prinzipien für die Anwendung des Plattformansatzes in anderen Ländern dienen können.

# Contents

# 1. Introduction

"Government as a Platform (GaaP) is a promising approach to the digital transformation of the public sector", stated Kuhn et al. [1]. GaaP adopted the concept of a platform from the private sector, where it showed ultimate success. Apple's triumph with the iPhone and applications is an excellent example of the platform strategy. Apple provided a platform connecting users and app developers, which led to more intensive application developments than competitors [2]. *Platforms* can be defined as sets of stable components that support variety and evolvability in a system by constraining the linkages among the other components [3]. They have the potential to enhance our lives by creating value through convenience for both owners and users, providing building blocks that serve as the foundation for complementary products and services [4]. Motivated by the success of platforms in the private sector, they increasingly receive attention in the public sector [5]. Countries sense the opportunity to improve their public agencies upon adopting the *digital platform* concept, commonly referred to as *Government as a Platform* or *GaaP*, as proposed by [6]. Government as a Platform (GaaP) is an approach to public service delivery which utilises digital infrastructure, services, and data to provide more efficient, cost-effective, and personalised services to citizens. The goal of GaaP is to simplify access to and use of government services [7]. The platform can support the evolution of public services with third-party applications and reduce the complexity of cooperation. It can be easily accessed and simplifies the modification and creation of services. Open data trends promote cooperation related to GaaP policy [2]. In addition, GaaP aims to remove duplication and break down organisational silos with lesser costs and more value [8, 7]. Nevertheless, difficulties arise when trying to implement GaaP in practice. As Kuhn et al. state, there are still no detailed guidelines or methods for digital government agencies to apply GaaP [1]; neither is there a single ultimate definition for GaaP [2]. The non-tangibility of the approach makes it difficult to explain and communicate to the stakeholders. An unoptimised balance between openness and control can lead to platform failure. Moreover, thinking based on the platform principles is challenging because they are contrary to current practices; the issue is referred to as a "failure of imagination" [1]. Lastly, implementing the concept can become demanding regarding financial and human resources, evolving into another barrier. The idea of transforming widely utilised *silo-based* systems into platform-oriented digital infrastructures using a framework proposed by [9] and discussed by [7] may serve as a solid foundation but still require additional tools and methods. Countries with the most prominent results in the adoption of GaaP are the UK, Estonia, and Italy [10, 11, 12]. In a previous research project, Poliarus could identify common patterns in their design decisions, which other interested countries can employ [13]. The purpose of this thesis is to develop an advanced set of patterns and collect and refine feedback on existing design patterns from their countries of origin and other relatively successful GaaP countries.

The research questions to be answered:

**RQ1:** What are the dimensions of design decisions in applying GaaP in practice?

**RQ2:** What are the design decisions of countries that successfully apply GaaP?

**RQ3:** Which design patterns can be derived from these decisions?

The second round of interviews with experts from the UK, Estonia and Italy has been analysed. Developing a coding concept, design patterns previously recognised in the first iteration were reevaluated, and extended [13]. In total, 50 design decisions and 15 design patterns were identified and clustered into six groups under four dimensions: platform architecture, roles/governance, principles and management. Overall, findings may imply that successful Government as a Platform (GaaP) implementations require user-centred design, openness, citizen involvement and collaboration, and thorough analysis of cultural, societal and political values.

The thesis is structured as follows:

- **Chapter 2** aims to provide a comprehensive review of the relevant literature, theories, and concepts related to the design patterns of a Government as a Platform, including a critical analysis of the existing research on this topic, highlighting the gaps and limitations, and laying the foundation for the subsequent chapters.
- **Chapter 3** outlines the research methodology used to investigate the design decision. It describes the research design, data collection methods, and analysis techniques employed, and provides a rationale for their selection.
- **Chapter 4** describes the research dimensions and the developed coding schema to for design decision analysis.
- **Chapter 5** delves into the design decisions that underpin the implementation of a Government as a Platform and discusses the design choices made by the governments studied and their implications for the platform's functionality, accessibility, and effectiveness.
- **Chapter 6** synthesizes the insights from the previous chapters and proposes a set of design patterns for a Government as a Platform, which includes best practices, guidelines, or frameworks that governments can use to design and implement a platform that delivers value to citizens, businesses, and other stakeholders.
- **Chapter 7** compares identified design patterns with previous findings and discusses the suitability of the term pattern.
- **Chapter 8** summarises the research approach and findings and concludes the contribution scale.

# 2. Theoretical Background

## 2.1. Government as a Platform

### 2.1.1. Current State of Affairs

In recent years, there has been a significant influence of intelligence information technology on various paradigms such as the economy, labour, social culture, politics, and public services. Several countries are grappling with issues such as low birth rates, ageing, and deflation, and investing heavily in intelligence information technology to overcome economic depression. Additionally, there is a growing public distrust in governments, particularly in the US, UK, Germany, and France, which, combined with the rapid growth of civil society and the limitations of representative democracy, has spurred a push towards digital transformation [14, 2]. Digital platforms have been successfully utilized in the private sector and are now receiving increasing attention in the public sector [4, 15]. The Government as a Platform (GaaP) strategy, introduced by [6] in 2011, has been considered a viable method for addressing the crisis in the public sector [2]. GaaP involves an open platform that aims to increase public value through the collaboration of citizens and the government [13].

Government as a Platform (GaaP) delivers better digital public services to citizens, emphasising the role of citizen engagement, including participation in the policy process [10]. It is based on reusing existing digital assets and processes to create shared digital infrastructure and services, which multiple agencies and departments can use. GaaP emphasises the role of high citizen engagement, including participation in the policy process. Such shared infrastructure and services can help reduce costs, improve efficiency, and reduce duplication of effort [16]. Breaking services into smaller, reusable components can make it easier for third-party developers and organisations to build services on top of existing infrastructure, allowing much quicker development of digital services. It reshapes governmental affairs through a shared APIs and components network, open standards, and standard datasets, providing better services that are more efficient, responsible, and safer for the public [8]. Various definitions of GaaP exist depending on the perspective of the area. There are numerous factors involved in creating and properly managing a platform. [17] suggested *modularity* and *openness* as characteristics of GaaP [2].

Breaking down a complex system into single discrete components that interact with each other through standardised interfaces within a standardised architecture helps manage complexity and facilitates and simplifies the process of innovation [18]. Therefore, modularity can reduce the cost of governance and modification and increase resource specialisation [17,

19, 2]. The independence of each modular platform component increases the flexibility of public administration; it may offer citizens more opportunities to personalise the consumption of public services, creating value and improving responsiveness to stakeholders [2, 13].

O'Reilly argued that the openness of the public administration could be vital in facilitating GaaP [2]. The public sector can become much more efficient and effective if all elements share and pool the assets, resources, and data they need [20]. Transparency and innovation can be tackled through open data [6]. GaaP provides a valuable framework to enable innovative and open production processes, which are needed to enhance the value public services generate and deliver while preserving centralised control [17]. In GaaP, open data can be perceived as raw materials to create public services and policies and encourage the private sector. Overall the emphasis on openness should engage and attract stakeholders, ultimately leading to value creation [2], since platforms in the public sector prioritise public value creation upon profit and emphasise authority, accountability, transparency, and citizen satisfaction over competition [21, 22].

The achievements of platform strategies employed by private sector entities like Apple, Amazon, Google, Facebook, and Netflix have prompted proposals that Government as a Platform (GaaP) could yield advantages in diverse domains, such as public services, policymaking, public value, and private enterprise. Within the context of public reform, GaaP has been identified as a potential next-generation government model that can address paradigm shifts in the zero-growth economy, the crisis in representative democracy, declining trust in government, and the need for increased civic engagement. GaaP has the potential to achieve these goals by leveraging smart abilities that accelerate public transformation [2].

### 2.1.2. GaaP Infrastructure

The public sector has historically developed infrastructures, such as highway or railway systems, upon which third parties have developed innovative business propositions and services. Given the distributed nature of these infrastructures, the public sector has yet to be able to exercise a high level of control over the developments that build on infrastructure. It is a significant challenge for the public sector to overcome the negative impacts of these developments on society and the values it aims to pursue [12].

One of the main reasons many public administrations among ICT-developed countries have recently paid attention to GaaP is cloud computing [23]. When GaaP was first introduced, the ICT infrastructures that could underpin it were not sufficiently developed [2]. The central infrastructure for GaaP is an integrated system that can embrace a separate system for each public agency. Limited in technical developments, initial GaaP studies could not suggest a concept of GaaP that works. However, cloud computing allows a government to implement GaaP beyond the ideal concept. By using the cloud, governments can easily integrate various public information systems, establishing a more effective and responsive platform for external stakeholders [23].

Any innovative government perceives ICT as a critical fundamental component [2]. ICT provides connectivity to all stakeholders and encourages communication. Seo & Myeong present intelligent information technology (IIT), data, and information systems as *infrastructure factors* [2]. Currently, the transformation process from silo-based to platform-oriented infrastructures is a topic in theory, and practice [7, 9]. One another important characteristic of infrastructure is that it starts offering value to users once a certain number of users has been achieved. The usages of infrastructures constantly evolve, and so do the types of users due to user diversity [21]. The platform *GOV.UK Pay* is an example of a shared infrastructure that enables all public agencies to receive payments online without creating their payment system. This type of platform can embed a medium control over the value creation process and is suitable to support the joined-up mode of production, which is typical of core public services, such as payment or identification services, that are useful for all public agencies [12]. The approach of GaaP is supposed to provide the overall environment with core features and infrastructure whereby the different authorities provide complementary services. However, research lacks an understanding of which elements should constitute a platform and, thus, infrastructure [5]. Technologies such as IoT, cloud, big data, AI, and blockchain can empower and operate GaaP. GaaP should work on cloud computing that can provide reliable storage and data analysis foundation, which can reduce the investment in IT infrastructure and improve the velocity and efficiency of business due to flexibility. Such substantial benefits motivate private industry and the public sector worldwide to introduce cloud computing into their infrastructures [2].

## 2.2. Platforms

### 2.2.1. Current State of Affairs

Platforms, in one form or another, have existed for a considerable amount of time. It is all about the means of *provision* and *connection*. Malls link consumers and merchants; newspapers connect subscribers and advertisers. The concept of a platform refers to a type of technology or service that serves as a foundation for other products, services, or businesses to build upon [24]. A platform can provide tools, technologies, and services that others can use to develop and deliver their products or services. A drastic boost in information technology has profoundly reduced the need to own physical infrastructure and assets. The creation and scaling of platforms have become extensively more straightforward and lesser in cost. Mainly, platforms have gained much attention in the private sector [2, 25, 13]. Smooth participation strengthens network effects and the ability to capture, analyze, and exchange vast amounts of data, creating more value [24]. The private sector provides several widely recognized thriving examples of technological areas and their associated "platform leader", such as Google, Apple, or Facebook [26, 18]. Definition by Baldwin & Woodard: "[A platform is] . . . a set of stable components that supports variety and evolvability in a system by constraining the linkages among the other components" [3]. Robertson & Ulrich define a platform relatively broader as

"the collection of assets that are shared by a set of products" [27]. Platforms typically have considerable numbers of users or customers who use them in different ways. They are prone to a *network effect*, meaning that as more users utilize it, it becomes more valuable to each user [24, 28]. It can also cause *indirect network effects*, implying that the more users it attracts, the more appealing it becomes to other businesses or organizations for participation and building on top of it [29]. Platforms come in different forms, such as digital platforms, physical platforms, and business platforms, with examples including social media platforms, mobile operating systems, and online marketplaces. Despite their variety, platforms share a common structure comprising four types of participants (Figure 2.1): *platform owners*, *providers*, *producers*, and *consumers* [2]. Platform owners control the intellectual property and governance of the platform, while providers serve as intermediaries for platform users. Producers create the offerings, and consumers utilize them [24]. Gawer highlighted different research perspectives on digital platforms [18]. While the *engineering perspective* considers technical architectures, the *economics perspective* perceives platforms as markets [5]. The economics perspective focuses on how platforms as markets coordinate communication across different customer groups and how network effects fuel platform demand and competition. The economic view helps explain why some platforms may achieve formidable dominance and almost reach monopoly, given the circumstances. Contrary, the engineering design perspective views product platforms as deliberately designed technological architectures (including interfaces) that generate modular product innovation, proposing that the design and use of platforms help companies achieve economies of scope in production, design and innovation [18]. Concerning the *platform scope*, Gawer et al. distinguish *company-specific (internal)* and *industry-wide (external)* platforms [30, 5]. Internal platforms are systems or applications developed and used within an organization to streamline business processes or enable internal communication and collaboration. These platforms may be hosted on the organization's servers or accessed through a private network. External platforms, on the other hand, are systems or applications that are available to the general public and accessed over the internet. [30] defined external platforms ". . . as products, services or technologies developed by one or more firms, and which serve as foundations upon which a larger number of firms can build further complementary innovations, in the form of specific products, related services or component technologies." Seo & Myeong stated that: "O'Reilly witnessed the success of Apple's platform strategy with the iPhone, and it inspired researchers to reinvent government by introducing the platform strategy in the public sector. This is the origin of GaaP that is related to platform businesses in the private sector" [23]. Applying and handling the platform strategy to the public sector is much more challenging than in the private sector due to its vertical nature and inflexibility; depends on how public administrations adjust and adapt. Nevertheless, GaaP's platform structural attributes make it a more innovative and creative model for government exceeding relatively simple e-Government [2].

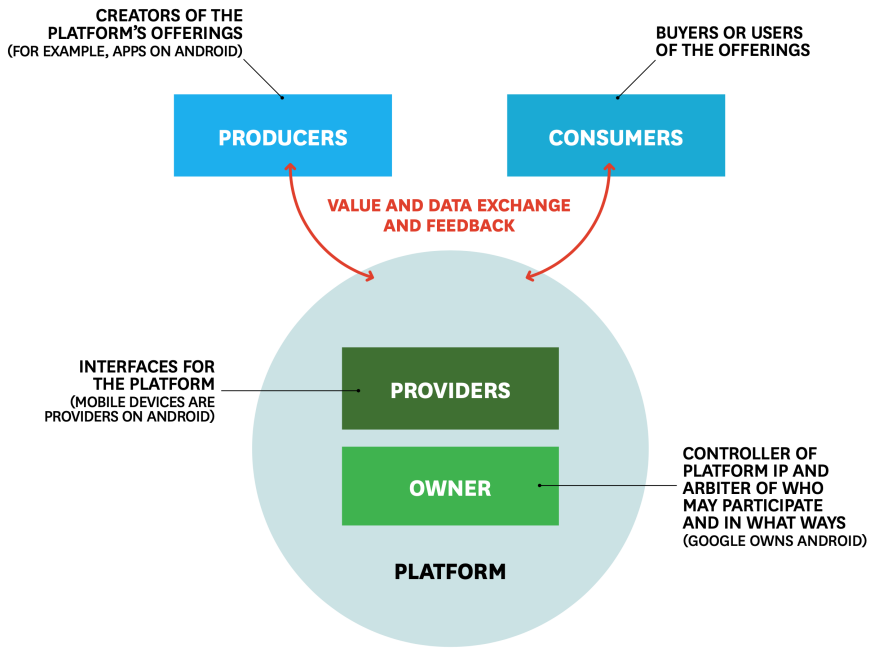


Figure 2.1.: Platform participants [24]

### 2.2.2. Platform-Oriented Infrastructure and Platformisation

The concept of Government as a Platform (GaaP) has gained increasing attention in recent years, as a means of using technology and digital tools to provide citizens with access to government services, information, and data. While there are some established principles such as openness, collaboration, and user-centered design, there remains a lack of standardized guidelines for the implementation of GaaP [7, 1, 6]. This is due to the inherent complexity of the public sector and the multifaceted nature of GaaP, which involves a wide range of stakeholders, including government agencies, technology providers, and citizens, which creates the need for the orchestration of active actors and coordinated action to create public value [1, 12, 6, 31, 32]. Moreover, the implementation of GaaP requires a context-specific approach, as the priorities, resources, and needs of a small local government may differ from those of a large federal agency [1]. Consequently, there is a need for further research and the development of evidence-based frameworks that can provide guidance for GaaP implementation. Baldwin & Woodard assert that ". . . the fundamental architecture behind all platforms is essentially the same: namely, the system is partitioned into a set of "core" components with low variety and a complementary set of "peripheral" components with high variety" [3, 33]. The *core components* of a platform are the fundamental building blocks essential for the platform to function and necessary for the platform to support the development and deployment of applications, products, and services. *Peripheral components* of a platform are additional features or functionality that are not essential for the main functionality of the platform but may be useful or desirable for some users or applications. For example, the core components of a cloud computing platform might include servers and storage, an operating

system, a runtime environment, and development tools, with peripheral services such as a database management system, a load balancer, or a messaging service. Ghazavneh & Henfridsson conceptualised the link between the two parts as *boundary resources* [7, 9, 34, 35]. Boundary resources allow various user services to communicate with the core and include two main processes: *resourcing* and *securing*. Resourcing indicates the level of provision of the ecosystem with the necessary technical and social resources while securing represents the extent of control achieved by the platform owner [9, 13]. Using a *platform-oriented infrastructure* can lead to cost savings through economies of scale (producing a large quantity of a product, leading to lower per-unit costs), economies of scope (producing a range of products using shared resources, leading to lower costs per product), and economies of substitution (using modular components that can be easily replaced or updated, rather than rebuilding the system from scratch) [36, 37, 38, 39, 3]. In fact, most of the world's digital infrastructures look much more like silo architecture than the clean-cut platforms of Apple or Airbnb [9]. The transformation process from silo-based to platform-oriented infrastructures is currently a relevant topic in theory and practice [7, 9, 40, 41]. "The starting point for *platformization* is the IT silo problem, characterised by many poorly integrated systems, with little flexibility for change, and slow innovation", suggests Bygstad & Hanseth [9]. *IT silo problem* refers to systems that are isolated from one another and operate independently. These systems are often created to address specific business needs or support specific organisational functions. Silo-based systems often require duplicate data entry and can result in redundant processes, which can be time-consuming and inefficient [42]. Siloed systems can make it difficult to get a comprehensive view of an organisation's operations, as data is often siloed and not easily accessible, leading to limited data visibility [43]. Overall, silo-based IT systems can hinder an organisation's ability to effectively and efficiently manage its operations, and additional developments for user needs. Figure 2.2 depicts a proposed simplified process of platformisation by Bygstad & Hanseth [9].

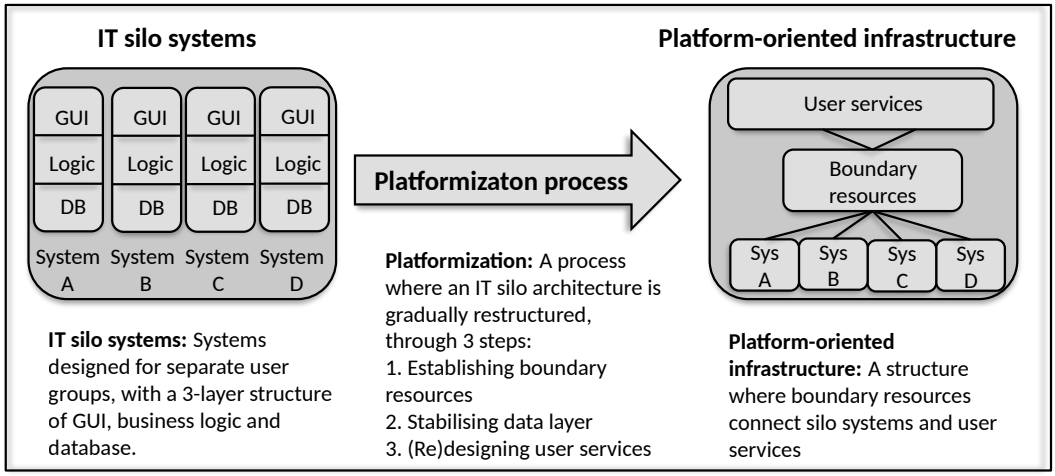


Figure 2.2.: Platformisation process [9]

## 2.3. Design Decisions, Design Patterns

### 2.3.1. Design Decisions

Efficient software architectures are responsible for regulating the communication and coordination between various stakeholders involved in software-intensive systems; the process of designing such architectures can be deemed as a decision-making procedure [44, 45, 46]. Sustainable *design decisions* are the foundation of sustainable architectures that endure constant software evolution [47]. Hansen & Andreasen contend that ". . . decision-making activities during the design process are complex, and the decisions made have [a] critical impact on the design solution, the business, and the design process" [48]. Understanding the concept and the decision-making process is necessary to answer our RQ1. The engineering designers need to assess the dependencies between the decisions, the priority of consideration of various aspects and what entities to finalise, all due to the intricate nature of design decisions [48]. Van der Ven et al. define an architectural design decision as: "A description of the choice and considered alternatives that (partially) realise one or more requirements. Alternatives consist of a set of architectural additions, subtractions and modifications to the software architecture, the rationale, and the design rules, design constraints and additional requirements" [49].

According to Falessi et al., three main factors drive software architecture design: *reuse* (an earlier version of the system, another system sharing key characteristics, architectural patterns, or organisation-wide experiences), *method* (choosing a correct systematic technique for bridging the gap between software architecture and requirements), and *intuition* [50, 51, 52, 53]. The architecture design process as a whole is an iterative process consisting of the following steps:

- Understand the problem (finding the essence and eliminating the ambiguities).
- Find a solution for the problem (decision-making on the most appropriate architectural design option).
- Evaluate the solution (evaluation of the appropriability of the chosen approach).

If, after evaluation, the problem is still feasible, but the solution approach is not acceptable, the architect moves on to the next alternative or reanalyses the requirements. If the problem is deemed infeasible, the requirements need to be readjusted. When the appropriate solution is found, the process ends [50].

### 2.3.2. Design Patterns

The subsystems of software architecture and their relationships typically consist of several smaller architectural units. Buschmann et al. describe these using *design patterns* [54]. They are not specific to software architecture and apply to various fields such as architecture, product design, industrial design, and project management [13]. The primary purpose of this thesis is to collect feedback on the design patterns from the representatives of multiple

GaaP-successful countries, so it is essential to deliver an understanding of the concept to the reader.

Design patterns in software architecture are standard solutions to recurring problems in software design and organization at a higher level of abstraction within specific contexts [55, 56]. Capturing effective problem-solving strategies for frequently occurring issues within a particular field as standardized patterns is widely recognized as an effective approach for sharing knowledge in domains that prioritize design [57]. Patterns provide a way to structure and organize the overall design of a software system, making it more scalable, maintainable, and extensible. Kuchana points out that design pattern is an effective means to communicate what has been learned about existing high-quality designs, leading to an emergence of a shared language for communicating the experience and a common vocabulary of system design elements for problem-solving discussions [56]. Reusing patterns helps decision-making to produce higher-quality software faster [55]. Gamma et al. propose four constituting elements of a pattern [58]:

- Pattern name allows a higher level of abstraction and a simpler reference for communication.
- The problem explains the context and the suitability of the pattern.
- The solution describes a general arrangement of elements in the solution approach, relationships, responsibilities, and collaborations but avoids any particular concrete design or implementation.
- The consequences represent the results and trade-offs of the pattern, which is critical for evaluating alternatives.

# 3. Methodology

## 3.1. General Approach

This work aims to collect and refine feedback on existing design patterns from GaaP-successful countries. A qualitative investigation into multiple successful cases appeared to be the most suitable research design methodology since the understanding of a specific phenomenon (implementation of GaaP) in its real-life context for different countries is sought [59, 60]. Detailed, in-depth data collection involving multiple sources of information was carried out for that purpose [61]. Italy, UK, and Estonia were chosen as cases for the research of government as a platform for several reasons. Italy was chosen for its recent efforts to modernize its public sector and increase citizen participation through digital transformation initiatives. The UK was selected for its reputation as a leader in digital government, having made significant investments in digital infrastructure and implemented innovative programs to improve citizen engagement. Estonia was recognized as one of the most advanced digital societies in the world, with a range of digital initiatives transforming the way citizens interact with government. Together, these countries represent a range of approaches to digital transformation and have implemented innovative programs and policies aimed at improving citizen engagement and participation. During the first iteration, an existing round of prerecorded interviews was analysed; even though they were not conducted with a deliberate inclination towards design patterns, common patterns were extracted and presented [13]. In order to confirm, disconfirm, reevaluate, extend and cross-check the existing patterns, a second round of interviews was conducted.

## 3.2. Case Descriptions

Countries Italy, UK and Estonia represent cases. They all have shown notable progress from the GaaP and platform engineering perspective. Table 3.1 provides an overview of the cases, built services and a corresponding number of interviews.

| Country | Services | Number of Interviews |
|---|---|---|
| Italy | SPID, CIE, PagoPA, ANPR, IO | 5 |
| UK | GOV.UK Portal, Verify, Pay, Notify | 2 |
| Estonia | X-Road, e-ID, eesti.ee | 3 |

Table 3.1.: Cases/countries overview

Italy has chosen the path towards the "operating system" of the country [62]. They have implemented a series of digital services as part of efforts to modernize their public administration system. These services are collectively known as the Government as a Platform (GaaP) initiative. One of the primary services is the *Secure Digital Identity (SPID)* system, which allows citizens and businesses to authenticate themselves and access public services online [63]. This system ensures that the identities of users are protected while accessing online services. Additionally, Italy has implemented an *Electronic Identity Card (CIE)* that provides verification during administrative procedures at public offices or situations that require identity verification [64]. The CIE is equipped with a chip that stores biometric data and other information, making it a secure form of identification. This digital identification card can be used in various settings, including banking, health care, and public administration services. Another digital service that Italy has implemented as part of its GaaP initiative is the centralized payment management system, *PagoPA* [12]. This system simplifies public administration payments and provides various payment options to citizens with minimal friction. The system is secure and has made it easier for citizens to pay their taxes and other public administration fees. Additionally, Italy has developed the *National Resident Population Register (ANPR)*, which aims to integrate the asynchronous registers of all municipalities into a national register containing the data of residents in Italy and Italians residing abroad [63]. This register will allow public administration services to access citizens' data, regardless of where they are located in Italy. Finally, the *IO* app is another service that Italy has developed to offer public services to citizens [65, 64]. The app is designed to make accessing public services more convenient for citizens. Users can use the app to perform a wide range of activities, including paying taxes, requesting official documents, and accessing information about public services. This app has been well-received by citizens and has made it easier for them to access public services.

The digital services developed by the UK government, as part of their Government as a Platform (GaaP) strategy, have effectively improved the efficiency and security of public service delivery. One such service is *Verify*, which provides a digital authentication process to ensure that user identities are protected and trusted when accessing online services [66]. This service has reduced the risk of fraud and made it easier for citizens to access online services, such as applying for benefits and paying taxes. The *Pay* service, which is another digital service developed by the UK government, simplifies the payment process for public administration services [66, 10]. It provides a secure online platform for citizens to pay their taxes and other fees related to public services, making it more convenient and efficient for users to manage their financial obligations to the government. *Notify* is a notification service developed by the UK government that keeps citizens informed about important government-related events or updates via text messages, emails, or letters. It is used to inform citizens about changes to public services, upcoming elections, and other significant government-related events. By providing timely and relevant information to citizens, Notify has helped to promote transparency and trust in government processes and increased citizen engagement with their local government [66, 10, 67].

Estonia has taken a different approach to implementing GaaP. The country has developed a secure, centrally managed, distributed middle-tier data exchange layer, *X-Road*, which has been in use for over 20 years [11, 68]. The X-Road system is designed to facilitate secure data exchange between various registries in Estonia. It ensures that the data is exchanged securely and that the privacy of users is protected. Additionally, Estonia has developed electronic identification services, including the electronic *ID (eID)*, *Mobile-ID*, and *Smart-ID* [68]. These identification services provide a secure means for citizens to authenticate themselves when accessing online services. Estonia's government services are accessible through *eesti.ee* and other service portals [11]. These portals are designed to provide citizens with a user-friendly interface for accessing government services online. Citizens can use these portals to perform a wide range of activities, including paying taxes, accessing healthcare services, and interacting with public administration services.

## 3.3. Data Collection

Ten interviewees from Italy (5), Estonia (3), and the UK (2) were contacted directly and invited to participate. Case studies can combine various data sources, such as interviews, archives, surveys, and observations [59]. A comprehensive literature review was conducted prior to the interviews to provide a theoretical background for the study. The review concerning the concepts of GaaP, platform-oriented infrastructure, platformisation, design decisions and design patterns locates in chapter 2. It helped develop the interview questions and provided a basis for understanding the common features of the GaaP approach present in each country according to the literature. The review also helped to assess design patterns that were noted in the first iteration of the study, as well as to establish a theoretical framework for the research. Semi-structured interviews were conducted online via video call and lasted approximately an hour each. To ensure the validity and reliability of the data collected, the answers provided by the participants were screen-captured with their consent. The interview details, including the participant's country of origin and the duration of the interview, can be found in the Table 3.2. The interview questions were based on common features of the GaaP approach present in the existing literature for each country and in the strategic documents, as well as on design patterns noted in the first iteration [13, 63, 65, 64, 62, 68, 66, 67].

## 3.4. Data Analysis

Initially, the interviews were transcribed using an AI tool which yielded time and effort savings in comparison to manual transcription. However, the accuracy of the automated transcription varied depending on factors such as the quality of the audio and the complexity of the language used. Subsequently, the transcriptions underwent manual review and correction to ensure their accuracy. This process involved carefully examining the text and rectifying any errors or omissions made by the automated tool. After the transcription process was completed, a coding schema was developed to capture the key ideas and concepts

discussed in the interviews. This involved creating a set of categories that could be used to code each text segment based on the relevant dimension. The coding schema was then applied to the interviews, involving reading through the transcripts and assigning codes to each text segment based on the relevant dimension. To clarify design decisions, a coding concept was applied to 10 interviews with representatives from Italy, Estonia, and the UK. This coding process involved carefully reviewing each interview and identifying relevant data segments that could be labelled according to the appropriate dimension. The purpose of this process was to systematically identify and extract design decisions from the data. Through this process, 415 quotes were extracted from the interview data and refined and grouped into a discrete set of 50 design decisions. Some of the design decisions were found to be similar or related to one another and thus emerged as six design pattern clusters. These patterns represent recurring design approaches identified across multiple interviews and may have important implications for the design process. Overall, the process allowed for a better understanding of the nature of each design decision and how it related to the broader research context.

| Country | Interview ID | Organisation | Role | Duration (min.) |
|---|---|---|---|---|
| Italy | 01-IT | Digital Transformation Team | CTO | 53 |
| | 02-IT | Presidency of the Council of Ministers | Expert in Support of PA Digitalisation Projects | 48 |
| | 03-IT | Digital Transformation Team | Technical Project Manager | 57 |
| | 04-IT | Advisory Group of Advanced Technology | Chairman | 34 |
| | 05-IT | Digital Transformation Ministry | Former Minister | 19 |
| UK | 01-GB | Cabinet Office | General Director, International Government Service and Digital Envoy | 45 |
| | 02-GB | GDS | Executive Director | 45 |
| Estonia | 01-EE | E-Governance Academy | Expert for Legal Aspects | 53 |
| | 02-EE | Cybernetica | Development Manager | 55 |
| | 03-EE | Government | Former Prime Minister | 35 |

Table 3.2.: Interviews

# 4. Coding Concept

## 4.1. Structural Dimensions

*Dimensions* in the analysis of research interviews refer to the use of a specific method, theoretical framework, or model to guide the interpretation and analysis of the data. A dimension acts as a set of rules or guidelines to follow during the analysis, which can help to ensure that the researcher is consistent in their approach and that the analysis is rigorous and systematic. As the structural dimensions, descriptive and prescriptive, were chosen.

*Descriptive dimensions* can be used to analyze research interviews to identify patterns or themes in the data and categorize or code the data according to specific criteria, such as the topics discussed, the attitudes or opinions expressed, or the language used by the interviewees. In research interviews, descriptive dimensions are commonly used in the data analysis stage to identify patterns and themes in the data [69]. These dimensions refer to the specific categories or criteria used to code or categorize the data, and they are typically derived from the research questions or objectives. Descriptive dimensions help researchers to identify commonalities and differences in the data and to draw conclusions or make inferences based on these patterns, allowing a more detailed and nuanced understanding of the data and in-depth analysis and interpretation [70].

By using a *prescriptive dimension*, more informed decisions about interpreting the data can be made, ensuring that the analysis is grounded in a rigorous and well-established methodology or theory [71, 72]. However, it is essential to note that the use of prescriptive dimensions in the analysis of research interviews can also have limitations, such as limiting the ability to explore alternative interpretations or perspectives and may result in a narrow or biased analysis of the data. The data may not fit neatly within the framework of the prescriptive dimension, requiring the researcher to adapt or modify the framework to make sense of the data. Prescriptive dimensions in the analysis of research interviews can be a valuable tool, but it is vital to use them in a flexible and open-minded way that allows for the exploration of the data from multiple perspectives.

To summarise, descriptive dimensions reflect the existing state of affairs and experience, whereas prescriptive include suggestions and recommendations.

## 4.2. Content Dimensions

*Platform Architecture* dimension determines a digital platform's fundamental structure, design, and functionalities. A platform's architecture can significantly impact its scalability, reliability, security, interoperability, and overall performance. It also affects how the platform can be extended and integrated with other systems or applications in the future. A well-designed platform architecture can support the development of innovative services, enable rapid deployment of new features, and facilitate collaboration among different stakeholders. Therefore, a thoughtful and strategic approach to platform architecture is critical for building successful and sustainable digital platforms [2].

Different stakeholders play essential roles in creating and delivering public services in the context of GaaP (Government as a Platform). These stakeholders may include the public, private, citizens and other external partners. The *Platform Owner* plays a primary role in establishing GaaP, but other participants' purpose in GaaP is also necessary for sustainable development. Citizens and other external partners can also contribute to developing creative output, creating a more valuable platform for all stakeholders [5, 2]. The platform roles dimension involves understanding the different roles essential to developing an effective platform strategy that considers the interests of all stakeholders and well and their match to these roles [73]. GaaP can foster horizontal cooperation among different stakeholders and leverage external innovation to create public value by embracing an open structure in both technical and organisational aspects [23].

*Platform Openness* dimension. In GaaP, platform openness is a key characteristic that enables innovative and open production processes to enhance the value of public services [23]. Open data is critical for instigating transparency and innovation and encouraging cooperative circumstances that aggregate citizens, experts, and non-experts. The platform provides boundary resources to allow for complements and to enable third-party applications to support the evolution of public services and reduce the complexity of cooperation, participation, and co-creation. Access to learning material and well-documented features are essential for new contributors to join the platform [5]. Open data attracts external stakeholders and supports the creation of new services, policies, and businesses [2]. Embracing more stakeholders is crucial for GaaP, and an open structure is necessary to converge these stakeholders.

*Platform Management* dimension refers to the set of activities and processes involved in managing the operation of a platform and orchestrating the activities of its users and service providers. Effective management and orchestration of a platform are crucial for achieving its strategic objectives and creating long-term value for its users and stakeholders [74]. By serving as a platform owner, the government can leverage the power of digital technologies to improve the efficiency, effectiveness, and accessibility of public services, promote transparency and accountability, and foster innovation and collaboration between government agencies and citizens [12].

## 4.3. Coding Concept

In the context of research interviews, *coding* involves analysing and categorising the interview data into themes, patterns, or categories. The purpose of coding in research interviews is to organise the data in a meaningful way that can help to identify and analyse the key ideas, concepts, and themes that emerge from the interviews [75]. The result of the coding process in research interviews is a set of codes or categories that can be used to analyse and interpret the data. These codes can be used to identify key ideas or themes from the interviews and develop insights and conclusions supported by the data. To create a thorough system for analysing interviews, structural and content aspects of identified design decisions were combined into a matrix. The matrix has eight questions, which are answered through a systematic analysis of the interview data. First, the design decision's structural component is identified and recognised as descriptive or prescriptive. Then it is categorised into one of the content dimensions.

| | **Architecture** | **Role/Governance** | **Principles** | **Management** |
|---|---|---|---|---|
| **Descriptive** | What decisions regarding the general architecture and components of the infrastructure have been taken in that country? | What decisions regarding roles of the infrastructure and components have been taken? | What decisions regarding the openness, participation and co-creation of the infrastructure have been taken in that country? | What decisions regarding the managnment of the infrastructure have been taken in that country? |
| **Prescriptive** | What are recommendations regarding the general architecture and components of the infrastructure that other countries should consider? | What are recommendations regarding the roles and governance of the infrastructure that other countries should consider? | What are recommendations regarding the openness, participation and co-creation of the infrastructure that other countries should consider? | What are recommendations regarding the management of the infrastructure that other countries should consider? |

Table 4.1.: Coding Matrix

# 5. Design Decisions

## 5.1. Reevaluation and Extension

Many countries have implemented Government asa a Platform (GaaP) initiatives to enhance government services by leveraging digital technology. These initiatives commonly involve the creation of digital platforms that provide services such as notifications, digital identity, payments, and citizen interaction. Centralization and decentralization of services are both considered, depending on the specific needs and requirements of the country. A key aspect of GaaP implementations is the development of digital identity, payment and notification systems. While some countries opt for a centralized digital identity system, others prefer a decentralized approach to improve security, privacy, and resilience risks. The digital identity system is typically used to facilitate secure identification, certification of properties, signing, and transmitting of documents. It is important to differentiate between identification and authentication tools and ensure that identity providers that are also service providers have separate operations for each to prevent misuse of data. Governments can provide libraries and frameworks to facilitate the adoption of electronic identity in service providers. Public services should also make use of electronic identity, and access control measures should be in place to ensure security. Privacy and GDPR compliance are also critical. Additionally, legal validity for URLs of documents is vital for intangible infrastructure, and a protocol system is essential for tracking the lifecycle of documents. The government platform should contain infrastructure building blocks for services like payments and notifications, with the possibility of interoperability to allow direct access to core databases across public administration and private companies. In addition, countries with GaaP initiatives focus on developing service standards, corporate identities, and mandatory frameworks to follow. To achieve successful GaaP initiatives, the government must set transparent governance and rules. The public sector services must conform to a higher level of accessibility, and there must be strong leadership with a single department responsible for legislation. Legislation should be reviewed to identify what does not fit rather than making many changes, and alignment from the top to the bottom of the structure is crucial. Additionally, having a technical board and digital transition team in each public administration may be helpful. Countries should focus on achieving goals that are at zero rather than improving things that are already finished, and the transformation of procedures within the public administration must receive a higher priority. Public administrations should create opportunities for people to work on things that matter, and building communities and having standards can facilitate this process. Incentives such as bonuses (e.g. cashback) can also encourage citizen participation. Hackathons can also be organized to create connections between developers and public administrations.

| | Descriptive |
|---|---|
| Platform Architecture | - National Register of the Resident Population.<br>- Digital identity.<br>- Digital payment system.<br>- The interoperability framework.<br>- Top 10 governments in the world use centralised solutions.<br>- Inclusion of contact details in digital identity profiles. |
| Platform Role/Governance | - Centralised project management and organisation.<br>- Have a strong, competent figure to lead the transformation process.<br>- Single department responsible for legislation.<br>- Different owners for different components.<br>- Subsidise conforming to the standards.<br>- Clear rules on information protection.<br>- Proactively making information available.<br>- Transparency of the parliamentary process (online broadcast).<br>- Legislation to keep public administration websites updated. |
| Platform Principles | - Open interoperability framework APIs.<br>- Open digital identity to private services.<br>- User accessibility.<br>- Design guidelines, templates and standards.<br>- Open-source public administration software.<br>- User-centered design approach.<br>- Data use transparency.<br>- Encourage citizens through bonuses.<br>- Create communities for developers and designers.<br>- Hackathons for public administration developers. |
| Platform Mangement | - Digital transition team in each public administration.<br>- Managing a centralised CMS is too complex.<br>- Each public administration should manage its own website.<br>- Avoid reinventing things from scratch.<br>- Hire young people with the right competencies.<br>- Know competencies and attainment levels of the employees.<br>- Incentivising with money is more effective than forcing control.<br>- Focus on a strategy. |

Table 5.1.: Prescriptive Design Decisions

| | Prescriptive |
|---|---|
| Platform Architecture | - Focus on specific needs and avoid reinventing the wheel.<br>- Services are provided centrally as components.<br>- Sometimes implementing a cenrallised service is impossible.<br>- Public services should make use of the electronic identity.<br>- Access control is necessary for security.<br>- Closed proprietary technology systems are not platforms.<br>- Differentiate between identification and authentication tools.<br>- Privacy and GDPR compliance.<br>- Legal validity for URLs of documents.<br>- Document lifecycle tracking.<br>- Implement a citizen notification system. |
| Platform Role/Governance | - Single owner per component.<br>- Public service APIs.<br>- Advisory service may not suit every country.<br>- Frequent law refinement.<br>- Avoid specialized tech-related laws.<br>- Alignment from the top to the bottom of the structure.<br>- Have a technical board. |
| Platform Principles | - Defining standards promotes evolution.<br>- Openness is a prerequisite for continuous development.<br>- Starting small can lead to a snowball effect in building a community.<br>- Create opportunities for people to work on things that matter.<br>- Investing in people's capability.<br>- Avoid proprietary software. |
| Platform Mangement | - Questioning widely adopted things is counterproductive.<br>- Focus on achieving goals at zero rather than improving ready components.<br>- The transformation of procedures within the public administration should be a priority. |

Table 5.2.: Prescriptive Design Decisions

Several architectural design decisions are quite representative and may serve as good examples for better intuition. One of the key design decisions is the creation of a National Register of the Resident Population, which provides a comprehensive database of citizen information. This enables digital identity verification and allows citizens to securely access public services. Digital identity is also critical, as it allows citizens to interact with government services online, and it should include contact details for seamless communication. A digital payment system is another essential component of a government as a platform initiative. This facilitates secure and efficient transactions between citizens and government services. Additionally, a well-designed interoperability framework is necessary to ensure that different systems can communicate and exchange data effectively. It is also crucial to focus on specific needs and avoid reinventing the wheel when implementing government as a platform initiatives. Providing services centrally as components rather than whole applications can help to reduce duplication and enhance efficiency. However, there may be cases where implementing a centralized service is not feasible or practical. Public services must make use of the electronic identity of citizens to ensure that they can access services securely. Access control is necessary to protect against unauthorized access and ensure the security of citizens' data. Closed, proprietary technology systems are not suitable for use in government as a platform initiatives, as they hinder collaboration and restrict access to data. It is essential to differentiate between identification and authentication tools to ensure the security and privacy of citizens' data. The privacy and GDPR compliance of any system should be a top priority. Finally, it is important to implement a citizen notification system to keep citizens informed about relevant changes or updates. By involving citizens in the development and maintenance of public services, government as a platform initiatives can empower them to take an active role in shaping their communities and contributions. Overall, a successful government as a platform initiative requires careful planning and attention to these key design decisions and architectural dimensions. When implemented effectively, it has the potential to transform how public services are delivered and improve the lives of citizens.

# 6. Design Patterns

## 6.1. Reevaluation and Extension

After analysing 50 design decisions, 15 design patterns were identified and clustered into six groups under four dimensions using the *rule of two* [13]. While most of these patterns have been successfully implemented, some are prescriptive and based on the representative's knowledge and experience, they are marked with *. The four dimensions that these patterns fall into are: platform architecture, platform role/governance, platform principles, and platform management. Based on the findings, the effective implementation of Government as a Platform (GaaP) necessitates the adoption of four primary infrastructure components: digital identity, digital payment systems, and interoperability frameworks. To ensure clear accountability and prevent duplicative efforts, a single owner should be designated for each infrastructure component and a competent leader should be appointed to oversee the transformation process. Openness is also crucial, enabling citizens, businesses, and other organizations to cooperate in developing and maintaining software solutions. GaaP initiatives should prioritize accessibility to create public services that are inclusive and accessible to all citizens. Ultimately, by empowering citizens to contribute to and shape their communities, they will be inspired to play an active role in addressing their community's challenges. However, it is important to note that the relevance and applicability of these patterns may vary depending on a country's specific context and requirements. Table 6.1 provides an overview of the extracted design patterns.

---

### Pattern 1: Main Functionalities

| | |
|---|---|
| **Context** | Implementing main infrastructure functionalities. |
| **Problem** | There are still no clear guidelines on the implementation of GaaP and what the first steps towards the infrastructure should be. |
| **Solution** | Implement three main GaaP infrastructure components: digital identity, digital payment system, and interoperability framework. |

*Prescriptive dimension

**Digital identity** is a foundational component of GaaP that enables citizens and businesses to access government services online securely. A digital identity system provides a way to verify the identity of an individual or organization, which is critical for ensuring the security of government services and protecting personal information. Digital identity systems can be based on different technologies, such as biometric authentication, smart cards, or mobile devices, and can be integrated with other government systems and databases. By implementing a robust digital identity system, government agencies can enhance the security and convenience of their services and streamline processes such as authentication and authorization.

**Digital payment system** is another critical GaaP infra component that enables citizens and businesses to pay for government services online. Digital payment systems can support various payment methods united in a single interface. By implementing a digital payment system, government agencies can reduce the cost and complexity of processing payments, improve the accuracy and speed of financial transactions, and increase the convenience and accessibility of their services for users.

**Interoperability framework** provides a standardized way for government agencies and systems to exchange and share data and services. It enables government agencies to integrate their systems and databases to provide a more seamless and integrated user experience. A robust interoperability framework can offer a range of benefits for government agencies and their users, such as reduced duplication, improved quality, increased innovation, and enhanced user experience. Interoperability frameworks should be based on common data standards, APIs, and other technical protocols and tools. They can also support a range of data formats and service delivery models to accommodate the needs of different stakeholders and service providers.

**Citizen notification systems** enable governments to communicate important information and updates to citizens promptly and efficiently. They are significant for emergencies, such as natural disasters, public health crises, or security threats. By implementing a citizen notification system, governments can reach citizens quickly and effectively, providing them with critical information and instructions to keep them safe.

Together, these four main GaaP infrastructure components can provide a strong foundation for a modern and efficient government service delivery system that is responsive to the needs of citizens and the private sector.

**Examples** Italy, UK, and Estonia have introduced services to facilitate secure online identification and payments. Italy has SPID for accessing public services, CIE for identity verification, and PagoPA for simplified payment management. The UK has Verify for digital authentication, Pay for secure payments, and Notify for notifications. Estonia uses X-Road for secure, centrally managed, and distributed data exchange between registries, and electronic identification services such as eID, Mobile-ID, and Smart-ID for secure identification.

## Pattern 2: Clear Governance

**Context** Management of digital transformation towards GaaP.

**Problem** Since few countries have applied GaaP, a successful management approach still needs to be more distinct.

**Solution** Have a strong, competent figure to lead the transformation process and just a single owner per component.

Leadership is critical to the success of any transformation process, including a GaaP implementation. A **strong, competent leader** can set the vision, provide direction, and ensure the transformation stays on track. They can build support for the transformation across the government and manage any resistance or challenges. A competent leader should have the necessary skills, experience, and authority to drive the transformation forward. They should be able to communicate the benefits of GaaP to stakeholders and ensure that the project stays within budget and on schedule. They should also be able to identify and manage risks and dependencies and adapt to changing circumstances.

Having a **single owner per component** is critical to the success of a GaaP transformation, which means assigning responsibility for each infrastructure component to a specific person or team, ensuring clear accountability for each element and that progress can be tracked and measured effectively. It also helps to prevent duplication of effort and ensure that each component is developed and implemented consistently and coherently. Having a single owner per component also increases stakeholder engagement and involvement throughout the transformation process, including representatives from different government agencies, external partners, and vendors. By involving stakeholders early and often, the GaaP transformation can be designed to meet the needs of all parties and ensure that it delivers the expected benefits.

In summary, clear governance is essential for the success of a GaaP transformation. By having strong, competent leadership and a single owner per component, governments can ensure that the transformation is well-managed and delivers the expected benefits to all stakeholders.

**Examples** Italy's government hired a person from a large-scale private sector enterprise who could envision the necessary changes and communicate them to others. In the UK, the minister took over the leadership role and could enforce needed changes towards digitalisation.

## Pattern 3: Embrace Openness

**Context** Openness, transparency, participation, and co-creation within a government.

**Problem** Accurately accessing a suitable level of openness.

**Solution** **User accessibility** is a critical aspect of GaaP initiatives as they aim to create public services that are inclusive and accessible to all citizens. To achieve this, governments need to develop user-centric designs that consider the needs and requirements of different user groups, including those with disabilities or those who may not have access to the latest technology. Accessibility must be inclusive and mobile-responsive, with government services available through multiple channels, including web portals, mobile apps, and social media platforms. Usability testing ensures that government services are user-friendly, intuitive, and easy to navigate. To ensure maximum accessibility, governments must design services with user needs in mind and continuously improve based on user feedback. Accessibility should be considered at every stage of the design process, from developing wireframes to testing the final product.

**Open-source public administration software** is a significant feature of GaaP as it enables governments to collaborate with citizens, businesses, and other organizations to develop and maintain software solutions. It is transparent, meaning anyone can view and modify the source code, which can help build trust between citizens and the government. Transparency can encourage innovation and collaboration, as citizens can see how their data is collected, stored, and used. Open-source software is typically more cost-effective than proprietary software, as it eliminates licensing fees and can be customized to meet specific government needs, helping save money on software development and redirect it towards other public services.

Involving citizens in the development and delivery of public services is a core principle of GaaP initiatives. Governments can empower citizens to take an active role in shaping their communities by **giving people opportunities to work on things that matter**. This can result in the sense of ownership and pride in the community, leading to greater civic engagement and participation. By engaging citizens in problem-solving, governments can increase efficiency in addressing public administration challenges. Citizens may be able to identify problems more quickly and suggest more efficient solutions, which can save time and resources.

**Examples** Italy has created legislation in which all public administration software should be open-source. Having no in-house developers, developers and designers were attracted through hackathons, and communities were created to allow people to participate in shaping their public services. Estonia also supports the notion of open-source and public contributions.

## Pattern 4: Guide the Way

**Context** The challenge to orchestrate digital conversion of numerous public administrations.

**Problem** Providing guidance and standards for public administrations, thereby creating unity and cohesion.

**Solution** **Design guidelines, templates, and standards** are essential for designers that provide a framework for the design process and ensure that the final product meets the necessary measures. Design guidelines offer a set of principles and rules that guide the design process, recommending elements such as layout, typography, colour, imagery, and other design elements. Templates offer pre-designed files that can be customized to fit specific needs, saving time and increasing efficiency by providing a structure for the design process. On the other hand, standards establish criteria for design quality and consistency, ensuring that designs are compatible with different devices and platforms while maintaining the integrity and quality of a brand. By following these tools, designers can create effective, accessible, and engaging designs that are consistent, high-quality, and meet the necessary standards, thus saving time and resources.

**Examples** An example of a user-accessible GaaP initiative is the UK Government's Digital Service Standard [76]. It provides guidance to government departments on how to design and deliver digital services that are user-friendly and accessible to all citizens. Italy also created an initiative of design guidelines to encourage public administrations to have a uniform design and reduce costs by providing templates.

## Pattern 5: Value Legacy

**Context** Deciding between implementing a new system or maintaining an old working solution.

**Problem** Potential improvement at the expense of tackling an unsolved issue.

**Solution** **Maintaining functional and up-to-date technology artefacts and communities** around them is crucial to preserving their usefulness and relevance for the future. A particular application or tool that still serves its intended purpose may be more cost-effective to maintain and update instead of building a new solution for the same problem from scratch. Similarly, communities can be built and nurtured around these artefacts to ensure that the knowledge and expertise surrounding them are preserved and can continue to flourish.

**Focusing on achieving goals at zero rather than improving ready components** involves prioritizing and creating new solutions that meet specific needs rather than constantly tweaking and improving existing components. Such an approach allows for greater flexibility and agility in responding to changing conditions and emerging challenges. By focusing on achieving goals at zero, GaaP governments can ensure that the solutions they create are fit for purpose and deliver maximum value to citizens and government agencies.

**Examples** SPID was under discussion to become discontinued, as the new option was possible. Yet, many have noted that it's a working solution with communities around it, which would've been a massive sunk cost had it been replaced.

## Pattern 6: Human Resource

**Context** Hiring people with the right skill set.

**Problem** The difficulty to organise work given scarce human resources due to tight competition with the public sector.

**Solution** The human resources (HR) aspect of GaaP emphasises the importance of hiring **young people with the right competencies and skills**. The recruitment process should focus on identifying candidates with the technical skills, creativity, and enthusiasm to work in a fast-paced and innovative environment. Countries can build an agile, responsive, and future-ready workforce by hiring young people who are enthusiastic about technology and digital innovation and willing to adapt to new challenges.

Countries should emphasise **assessing and tracking employees' competencies and attainment levels** to ensure that employees have the necessary skills and knowledge to succeed, which involves identifying each employee's strengths and weaknesses and tracking their progress through various training and development programs. By doing so, administrations can tailor their training and development efforts to each employee's needs, ensuring they have the support and resources necessary to reach their full potential.

**Solution** **Investing in people** is essential to creating a positive and productive work environment. By providing employees with the necessary resources and support to do their job well, public administration can foster a culture of trust, collaboration, and continuous improvement. This involves creating opportunities for employees to learn new skills, take on new challenges, and contribute their ideas and expertise to the organisation. When employees know their work is valued and appreciated, they are more likely to feel motivated and engaged, reducing the need for punitive measures to enforce compliance.

**Examples** The UK used an employee competency and attainments assessment system for better HR management. Italy and Estonia support open-source public administration software and provide opportunities for developers to participate and collaborate on their country's digital transformation.

| | |
|---|---|
| Platform Architecture | **Implement four main GaaP infrastructure functionalities**:<br>- Digital identity.<br>- Digital payment system.<br>- Interoperability framework.<br>- Implement a citizen notification system.* |
| Platform Role/Governance | **Clear governance**:<br>- Have a strong, competent figure to lead the transformation process.<br>- Have a single owner per component.* |
| Platform Principles | **Embrace openness**:<br>- User accessibility.<br>- Open-source public administration software.<br>- Give people opportunities to work on things that matter.*<br><br>**Guide the way**:<br>- Design guidelines, templates and standards. |
| Platform Management | **Value legacy:**<br>- Maintain functional artefacts and communities<br>around them.<br>- Focus on achieving goals at zero rather than improving ready components.*<br><br>**Human Resources**:<br>- Hire young people with the right competencies.<br>- Know the competencies and attainment levels of the employees.<br>- Invest in people. |

Table 6.1.: Design Patterns Overview

# 7. Discussion

The objective of this thesis was to collect and refine feedback on existing design patterns for platform engineering within the public sector, using the successful experiences of three governments as a basis. The accomplishment of this objective was approached by addressing three distinct research inquiries. Firstly, a coding system for interview analysis was developed. Secondly, emphasis was placed on the design choices implemented by the countries under examination in the execution of the GaaP model. Lastly, design patterns were extracted from the identified design decisions.

The resulting compilation comprises six distinct pattern clusters and effectively summarizes optimal design practices across public sector platform engineering dimensions. As a result, it provides a comprehensive overview of the shared solutions employed by Estonia, the UK, and Italy, which can be adopted by other governments to efficiently implement the Government as a Platform (GaaP) model. Overall, the analyzed countries demonstrate a clear emphasis on the architecture and management of the platform during GaaP implementation.

A design pattern documents a solution for a recurring problem given a specific context [57]. Our descriptive design patterns are based on experts' experiences and practical applications, which have been shown to lead to successful solutions for the respective problems, as per the feedback received through interviews. However, it is worth noting that some patterns were presented as suggestions and carry a prescriptive nature, implying that they are recommendations rather than strict guidelines.

According to current findings, the successful implementation of the Government as a platform (GaaP) requires adopting four main infrastructure components: digital identity, digital payment systems, and interoperability frameworks. A strong, competent leader should be appointed to lead the transformation process, and each infrastructure component should have a single owner to ensure clear accountability and prevent duplication of effort. Embracing openness is also important, as it allows citizens, businesses, and other organizations to collaborate in the development and maintenance of software solutions. Additionally, accessibility should be a critical aspect of GaaP initiatives, as it aims to create public services that are inclusive and accessible to all citizens. Finally, giving citizens opportunities to work on things that matter can empower them to take an active role in shaping their communities and contributions.

The previous work on design patterns for Government as a Platform (GaaP) suggests building three essential components: digital identity, interoperability system, and interface

for accessing public services [13]. These components facilitate data matching, smooth data exchange between authorities, and enable the creation of other digital services. The research also suggests implementing a distributed architecture, transparent data management, collaborating with the private sector and making digital public services user-centric with incentives for usage. Additionally, it recommends organizing free educational programs on using digital public services and making digital identity compulsory for everyone to ensure its high usage and fast integration in public services [13].

When comparing the findings with the previous set of patterns identified in [13], it is evident that some patterns matched, and some extended the existing set. The first iteration focuses more on the technical aspects of GaaP, such as data management, cloud computing, and security. The second iteration, on the other hand, includes technical components such as digital identity and digital payment systems, but also counts non-technical features such as citizen notification systems and the importance of managerial factors such as competent leadership, clear governance and human resource. It also highlights the importance of embracing openness and involving citizens in the development and delivery of public services. Overall, both sets have a common goal of providing efficient, effective, accessible and transparent user-centred government services to citizens and greatly complement one another. Table 7.1 demonstrates patterns from both iterations next to each other.

After all, can the findings even be labelled as patterns? The number of cases examined in a study can significantly impact the applicability of design patterns. A study that only examines a few cases may not provide enough evidence to support the general applicability of design patterns. Multiple cases from different contexts need to be considered to ensure the accuracy of their findings. Three case studies might not be enough to conclude the applicability of design patterns in all countries; while case studies are useful for exploring specific instances, they may only sometimes provide enough evidence to draw universal conclusions. The applicability of design patterns may vary depending on the country, and further research is necessary to determine their effectiveness. While some countries may appear similar in development, there can be significant differences in their culture, politics, and societal values. These differences can have an impact on the applicability of identified design patterns. The rule of two is a helpful evaluation measure. However, its sufficiency is questionable in evaluating a pattern: The rule of two is a criterion that evaluates the effectiveness of a design pattern based on the presence of at least two examples of its successful implementation analogically to Coplien's rule of three [13, 77]. Other factors, such as cultural differences or political systems, can also impact the effectiveness of a design pattern. A design pattern that works in one country may not necessarily work in another country. Countries have unique characteristics that can impact the applicability of design patterns. For instance, Italy still cannot support a citizen notification system due to difficulties with legislation. Such unique characteristics should be considered when evaluating the effectiveness of design patterns in different contexts. Some features considered necessary in one country might not be necessary for another. For example, the UK does not support open-source public

administration software due to security measures, while Italy is all for transparency and citizen collaboration encouraged by open source. Countries have unique characteristics that can impact the components required for a design pattern to be effective in different contexts.

*Design theory* can be defined as a ". . . normative or prescriptive type of theory, which gives guidelines or principles that can be followed in practice [78]", which may be a finer classification of the findings, than patterns, since they come as clusters of solutions, approaches and recommendations. Design theories, as such, are more complex and would require further and deeper research towards each constituent [71].

| | [13] | Current Findings |
|---|---|---|
| Platform Architecture | - Identity, interoperability and interface.<br>- Distributed architecture. | **Implement four main GaaP infrastructure functionalities:**<br>- Digital identity.<br>- Digital payment system.<br>- Interoperability framework.<br>- Implement a citizen notification system. |
| Platform Role/Governance | - Compulsory digital identity. | **Clear governance:**<br>- Have a strong, competent figure to lead the transformation process.<br>- Have a single owner per component. |
| Platform Principles | - Transparent data management.<br>- Public-private partnership.<br>- User-centric services with incentives.<br>- Educational programs. | **Embrace openness:**<br>- User accessibility.<br>- Open-source public administration software.<br>- Give people opportunities to work on things that matter.<br><br>**Guide the way:**<br>- Design guidelines, templates and standards. |
| Platform Mangement | | **Value legacy:**<br>- Maintain functional artefacts and communities around them.<br>- Focus on achieving goals at zero rather than improving ready components.<br><br>**Human Resources:**<br>- Hire young people with the right competencies.<br>- Know the competencies and attainment levels of the employees.<br>- Invest in people. |

Table 7.1.: Design Patterns Combined

# 8. Conclusion

Government as a Platform is an innovative concept that offers potential benefits to the public sector in terms of increased efficiency, reduced costs, and improved citizen engagement. However, this concept is still in its early stages, and concrete techniques and practices are lacking to guide its implementation. This thesis aimed to bridge this gap in the literature by proposing a set of practices that can serve as a solid foundation for designing a platform in the public sector.

A systematic approach consisting of three stages was performed: first, the development of an appropriate coding schema for the extraction of design decisions based on their dimensions; second, the identification of successful design decisions made by Estonia, the UK, and Italy in their GaaP implementations; and third, the derivation of design patterns from the practical experiences of these countries.

The developed coding schema represents a matrix that classifies decisions from two perspectives: their structure and their content. This schema proved to be a suitable approach for the data analysis in this study. The content dimensions are essential for describing the scope of a decision within the GaaP model, while the structural dimensions give a comprehensive overview of the problem that caused this decision and the reason for choosing a particular solution.

The handling of issues in various areas of platform development, including platform architecture, roles, openness, and management, is described by 60 design decisions. Additionally, these decisions highlight the areas the countries interviewed focused on the most during the construction of GaaP, as well as the implementation challenges that were the most difficult to overcome. Finally, six derived design patterns generalize decisions filtered by the evaluation criterion and provide valuable practices for designing a platform in the public sector. These patterns build orientation for other countries while applying the GaaP concept, providing practical and theoretical guidance.

Despite the contributions of this thesis, it has limitations. The number of analyzed cases is restricted to three countries, and additional research is necessary to increase confidence in the generalizability of the proposed practices. In summary, our study provides valuable insights into the multifaceted aspects of platform design, encompassing critical elements such as system components, structure, and management. These empirical findings can contribute to the advancement of scholarly knowledge and inform evidence-based practices related to Government as a Platform in the public sector.

# A. General Addenda

If there are several additions you want to add, but they do not fit into the thesis itself, they belong here.

## A.1. Detailed Addition

Even sections are possible, but usually only used for several elements in, e.g. tables, images, etc.

# List of Figures

# List of Tables

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