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BALANCING STABILITY AND AGILITY: THE ROLE OF SOFTWARE ECOSYSTEMS IN ENHANCING PUBLIC SERVICE DELIVERY IN THE PUBLIC SECTOR

JYVÄSKYLÄN YLIOPISTO
INFORMAATIOTEKNOLOGIAN TIEDEKUNTA
2024

TIIVISTELMÄ

Kolehmainen, Taija
Vakauden ja ketteryyden tasapainottaminen: Ohjelmistoekosysteemien rooli julkisen sektorin palveluiden tuottamisen tehostamisessa
Jyväskylä: Jyväskylän yliopisto, 2024, 58 s.
Tietojärjestelmätiede, pro gradu -tutkielma
Ohjaaja: Pekkola, Samuli

Tämä artikkelipohjainen pro gradu -tutkielma tarkastelee, kuinka julkisen ja yksityisen sektorin toimijoita yhteen tuovat ohjelmistoekosysteemit parantavat julkisten palveluiden tuottamista mahdollistamalla tasapainoilun vakauden ja ketteryyden vaatimusten välillä. Julkishallinnon organisaatiot kohtaavat kasvavaa painetta sopeutua ja olla kestäviä muuttuvassa toimintaympäristössä. Erityisesti kriisitilanteet paljastavat perinteisten jäykkien ja hierarkkisten palvelumallien rajoitukset. Tutkimus keskittyy vastaamaan keskeiseen kysymykseen: "Kuinka ohjelmistoekosysteemit parantavat julkisten palveluiden tuottamista julkisella sektorilla tasapainoillen vakauden ja ketteryyden tarpeiden välillä?"

Tutkimuksessa hyödynnetään laadullista analyysiä ja tarkastellaan kahden pääartikkelin löydöksiä. Ensimmäinen käsittelee Suomen Omaolo-terveyspalvelua, joka mukautui nopeasti pandemian aikana, ja toinen tarkastelee kokonaisarkkitehtuurin roolia julkishallinnon ekosysteemeissä. Tutkimuksessa kerättiin näkemyksiä kirjallisuudesta ja pääartikkeleista, joiden avulla analysoitiin, miten johtajuus, hallinto ja yhteistyö edistävät järjestelmän ketteryyttä ja vakautta.

Keskeiset löydökset osoittavat, että ohjelmistoekosysteemit parantavat julkisten palvelujen tehokkuutta yhdistämällä resursseja, edistämällä innovointia ja parantamalla organisaatioiden sopeutumiskykyä. Tässä tutkimuksessa korostuvat hallintorakenteiden, kuten yritysarkkitehtuurin, merkitys vakauden ylläpitämisessä ja joustavuuden mahdollistamisessa. Selkeä viestintä, vahva julkisen ja yksityisen sektorin yhteistyö ja mukautuva johtaminen ovat avainasemassa ketteryyden ja vakauden tasapainottamisessa. Jatkuva kehitys ja uudelleenmuotoiltavat prosessit varmistavat sekä reagointikyvyn että pitkän aikavälin kestävyyden julkisten palvelujen tarjonnassa.

Tässä tutkimuksessa havaitsin, että julkiset organisaatiot voivat omaksua ketteryyttä tehokkaammin kuin aiemmin on ajateltu, erityisesti kriisitilanteissa. Yritysarkkitehtuuri voi vakauden rinnalla lisätä ketteryyttä mahdollistamalla järjestelmän joustavan uudelleenkonfiguroinnin. Tarvitaan lisää tutkimusta sen selvittämiseksi, miten kriisien aikana toteutetut toimenpiteet voidaan vakiinnuttaa pitkän aikavälin hallintomalleihin. Lisäksi tarvitaan lisätutkimuksia johtamistyyleistä ja organisaatiokulttuurin muutoksista, jotka parhaiten edistävät jatkuvaa parantamista ja innovointia julkisen sektorin ekosysteemeissä.

Asiasanat: ohjelmistoekosysteemit, julkisten palveluiden tuottaminen, julkisen ja yksityisen sektorin yhteistyö, organisaation reagointikyky, pitkän aikavälin palveluiden kestävyys

ABSTRACT

Kolehmainen, Taija
Balancing Stability and Agility: the Role Software Ecosystems in Enhancing Public Service Delivery in the Public Sector
Jyväskylä: University of Jyväskylä, 2024, 58 pp.
Information Systems, Master's Thesis
Supervisor: Pekkola, Samuli

This is an article-based Master's thesis that explores how software ecosystems, integrating public and private partners, improve public service delivery by balancing stability and agility. Public sector organizations face increasing pressure to be adaptive and resilient, particularly during crises like the COVID-19 pandemic, which exposed the limitations of traditional rigid and hierarchical models of service delivery. The research focuses on answering the central question: "How do software ecosystems improve public service delivery in the public sector while balancing the need for stability and agility?"

The study employs a qualitative analysis of the findings of two primary articles: one on Finland's Omaolo e-health service, which demonstrated rapid adaptation during the pandemic, and another on the role of Enterprise Architecture in government ecosystems. Insights were gathered from literature and primary studies, analyzing how leadership, governance, and collaboration contribute to system agility and stability.

Key findings reveal that software ecosystems enhance public service efficiency by pooling resources, fostering innovation, and promoting adaptability. The study highlights the role of governance structures like Enterprise Architecture in maintaining stability while enabling flexibility. Clear communication, strong public-private collaboration, and adaptive leadership are key to balancing agility and stability. Continuous improvement and reconfigurable processes ensure both responsiveness and long-term resilience in public service delivery.

The study concludes that public sector organizations can significantly improve service delivery by adopting software ecosystems that integrate both stability and agility. In this study, I discovered that public organizations can adopt agility more effectively than previously thought, particularly in crisis situations. Enterprise Architecture does not only support stability but also enhances agility by allowing flexible system reconfiguration. More research is needed to explore how measures implemented during crises can be institutionalized into long-term governance models. Additionally, further investigation is needed into leadership styles and organizational culture shifts that best facilitate continuous improvement and innovation in public sector ecosystems.

Keywords: software ecosystems, public service delivery, public-private collaboration, organizational responsiveness, long-term service sustainability

PREFACE

I am grateful to have had the chance to finish my studies with this specific research topic on public ecosystems and their governance. I believe it is a step toward solving some of the bigger societal challenges we face. My interest in the topic comes from wanting to explore how we can balance the needs of society with the fast-changing world of technology. I have always been fascinated by how different systems connect and interact to form something larger.

I have been fortunate to receive support and guidance from numerous individuals throughout the years. I want to sincerely thank my supervisor, Professor Samuli Pekkola, for guiding me through the process and helping me develop the academic skills I needed to finish this thesis. I am equally grateful to Professor Tommi Mikkonen for his encouragement and for pushing me to finish the work. I also want to extend my gratitude to my co-authors in the articles that form the basis of this thesis, whose insights and teamwork made this research possible.

I am deeply thankful to Professor Pekka Abrahamsson, who introduced me to academia. Learning from him taught me the importance of academic passion and always striving to outdo myself. His dedication to building a supportive community has provided me with a network that still guides me today.

A special thank you goes to Dr. Gabriella Laatikainen, with whom I have spent countless hours researching and teaching about ecosystems and their governance. Her mentorship, alongside Dr. Juha-Pekka Tolvanen, with whom we developed the Ecosystem Governance Compass modeling tool, has been invaluable.

My colleagues and the wider research community at StartupLab have been a constant source of inspiration. They have shared ideas, offered support, and shown me the true power of collaboration.

I also want to thank my family for their ongoing support, even if they are not always sure what I am working on! My grandmother encouraged me to study further, while my mother reminded me to enjoy life along the way. Although they are not here to see this moment, their influence is with me every step.

To my partner, Jukka, thank you for being there, especially during the tough moments, and to my other loyal companion, Tytti the cat, who never left my side during the long night hours of work. And, of course, my friends, who have been there every step of the way, making sure I had plenty of fun and balance.

My academic journey started in 2019 in the Faculty of Information Technology at the University of Jyväskylä. That experience gave me the push I needed to dive into research and provided the resources to do so. It has been a long road—starting my studies 10 years ago, trying different career paths, and finally finishing my master's degree in a world that has changed so much. I truly believe that technology has a unique role in supporting society now more than ever.

Jyväskylä, 27 September 2024
Taija Kolehmainen

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1 INTRODUCTION

During the COVID-19 pandemic, Finland's Omaolo e-health service became a critical tool in responding to the pandemic and delivering fast, efficient healthcare services to citizens. What set Omaolo apart was its ability to rapidly adapt to the evolving crisis, transforming traditionally rigid public sector collaboration strategies into a flexible, responsive environment. This case illustrates a key issue: how can public organizations balance the need for stability with the flexibility to adapt in times of crisis? The success of Omaolo highlights the urgent need for governments to adopt software ecosystems that foster both innovation and resilience in public service delivery.

Public service delivery faces increasing pressure to become more efficient, flexible, and responsive. Governments must adapt to shifting technological landscapes and rising citizen expectations, particularly in the domain of information and communication technology (ICT) systems. Traditionally, public sector organizations are perceived as rigid and slow in decision-making, particularly in renewing systems (Koski, 2019). In Finland, public systems architecture is fragmented, with siloed systems operating in isolation (Ghezzi et al., 2024; Nurmi, Penttinen, et al., 2019). This rigidity is often attributed to a combination of limiting attitudes toward change and organizational structures that suppress innovation and adaptability (Ghezzi & Mikkonen, 2024). Communication and collaboration challenges further contribute to these issues, with misaligned objectives and poor coordination across government levels delaying projects and impacting knowledge-sharing and, ultimately, service quality for citizens (Pekkola et al., 2022).

ICT procurement in the public sector differs significantly from the private sector, where software development is often driven by economic needs. In contrast, public sector ICT initiatives are guided by long-term strategic goals, with the expectation that systems will serve extended periods without significant modification (Koski, 2019). This can lead to acquisition procedures designed around legacy systems rather than proactive steps toward adopting new systems or processes (Ghezzi & Mikkonen, 2024). Furthermore, procurement laws and regulations place strict constraints on tendering processes, making it difficult to

foster collaborative relationships with vendors (Ghezzi & Mikkonen, 2024; Holma et al., 2020). Together, these organizational, regulatory, and technological challenges make ICT projects challenging to develop and maintain, often hindering the adoption of agile methodologies in public service delivery (Nuottila et al., 2016). This can create tensions between public procurement units and vendors, particularly regarding system requirements and regulatory interpretations (Ghezzi & Mikkonen, 2024).

While existing literature has explored the challenges of ICT procurement and public sector rigidity, less attention has been given to how software ecosystems can help public organizations overcome these barriers. In the public sector, software ecosystems, where public and private organizations collaborate on developing and maintaining ICT systems (Jansen et al., 2009), have emerged as a promising strategy to address these challenges. These ecosystems allow public organizations to pool resources, share risks, and access cutting-edge innovations, enhancing their ability to respond to changing demands (Basole et al., 2015; Jansen, 2014). However, successful collaboration within these ecosystems requires careful consideration of strategic, social, and management factors. There is a need to further investigate how public-private collaboration within software ecosystems can improve service delivery by fostering both flexibility and long-term resilience. This thesis addresses this gap by examining the role of software ecosystems, with a focus on identifying the key factors that contribute to stability and agility in public sector ICT projects.

1.1 Research Problem and Research Questions

The primary aim of this thesis is to explore how public sector organizations can leverage software ecosystems to improve efficiency, adaptability, and long-term sustainability. By analyzing two perspectives on the topic, including the case study on Omaolo's e-health service in Finland (Kolehmainen et al., 2024) and the role of Enterprise Architecture in government ecosystems (Ghezzi et al., 2024), this research identifies key strategies and enablers that balance agility and stability when delivering public services public software ecosystems. The research reveals how leadership, governance structures, clear communication, and collaborative practices contribute to successful outcomes in these ecosystems.

The motivation for this research stems from a desire to understand how adopting an ecosystem perspective and collaborative mindset can enhance organizational operations and impact. Implementing such changes, especially in the public sector, poses significant challenges. The public sector's unique context offers a valuable opportunity to explore these issues. The goal of the research is to improve the efficiency and effectiveness of public service delivery by promoting a better knowledge of software ecosystems. The research question is, "*How do software ecosystems improve public service delivery in the public sector while balancing the need for stability and agility?*".

To address this, the study has the following objectives: identify stability and agility factors in the public sector and explore strategies for balancing these forces. The additional research questions are:

1. *How can public sector organizations maintain stability within software ecosystems?*
2. *How can public sector organizations incorporate agility and flexibility into software ecosystems?*

In conclusion, this research offers critical insights for public sector leaders and policymakers on designing more effective software ecosystems that not only improve agility but also ensure the stability necessary for reliable public services.

1.2 Thesis Structure

The thesis begins with an introductory section that provides background on the primary articles, outlines the research task, and presents the research questions. Following this, the Literature Review synthesizes relevant theoretical and research literature to support the discussion of the article results. The thesis explores the tensions between stability and agility requirements in public service delivery provided by the primary articles and reflects on these findings in the context of earlier research.

The Summary of the Articles section details the practical implementation of the studies, including the research design, data collection, and analysis methods used in the primary articles. It also outlines the author's contributions to these articles. Further, the section concisely presents the key findings and contributions of the two primary articles and explains how they address the research question. The full articles are included in the appendix.

Finally, the Discussion analyzes the connections between the articles and previous research, critically evaluating the thesis process and its implications, and suggesting further research topics. The results of this thesis are summarized in the Conclusion section.

2 LITERATURE REVIEW

The delivery of public services must balance the need for reliability and consistency (stability) with the ability to adapt to changing demands (agility) while taking advantage of technological innovations (via, e.g., ecosystems). The influence of digital and software ecosystems on the shaping of public service delivery is becoming increasingly evident. Ecosystems are complex and interdependent networks in which participants interact and evolve collaboratively in order to create value. In this thesis, I explore software ecosystems where public and private organizations collaborate to deliver public services, sharing technologies and processes.

Next, I will go through three key themes: the process and challenges of acquiring public ICT systems, agility and change in public organizations and finally, I will look into ecosystem approach in the public sector. The first part supports understanding the requirements of public service delivery and the dynamics of inherent tensions in public-private collaboration. The second part describes how agility affects service delivery in the public sector. Finally, the third part provides the foundation needed to understand the context in which the public organizations operate in today's business landscape.

2.1 Public Service Delivery and Purchasing ICT Systems

Purchasing software or platforms in the public sector differs significantly from the private sector due to its complex legal and organizational procedures (Ghezzi & Mikkonen, 2024; Holma et al., 2020) and complex stakeholder dynamics (Nuottila et al., 2016; Riihimäki & Pekkola, 2021). Public procurement serves as the primary channel through which software ecosystems are introduced into public sector organizations. This section sets the base for understanding the complexities of acquiring software in the public sector by introducing the procurement process, giving a high-level view of its challenges and suggested solutions, and,

finally, discussing the different aspects of public-private collaboration when delivering ICT solutions to the public sector.

2.1.1 Public ICT Procurement Process in Finland

Public ICT procurement refers to the structured process by which government organizations acquire ICT products and services, including software and platforms. The adoption of the procurement policies and guidelines varies at a national level. In Finland, the public procurement process, such as vendor selection, contract negotiations, and software management, is governed by strict legal frameworks and standards designed to ensure transparency, fairness, and cost-effectiveness (Procurement Directive, EU, 2014). These constraints can sometimes impact the flexibility needed to implement agility in public service delivery.

In addition to directives set by the European Union and national legislation and oversight, the Finnish contracting public entities need to follow the World Trade Organization's Agreement on Government Procurement. In Finland, the Ministry of Economic Affairs and Employment is responsible for national legislation (Acts on public contracts)[1], and the Ministry of Finance provides general guidance and manages the central government procurement activities. Additionally, the Ministry of Finance determines which public contracts will be subject to a centralized tendering process. Despite the standards and laws, human judgment has a significant role in the procurement process in Finland, leading to varying disputes among stakeholders (Ghezzi & Mikkonen, 2024). It is, therefore, a setting of multiple actors and multiple overlapping laws, which requires participants to have a broad understanding of the procurement process.

The Public Procurement Act applies to procurement by a public agency outside its own organization. In some cases, the Procurement Act may also apply to a company if it receives public support. Public procurement must be put out to tender when its estimated value exceeds a certain threshold[2]. Procurement can happen in several different ways, yet there are three obligatory phases: announcing the upcoming tender, tendering, and vendor selection. In the literature, the process is generally divided into the following main phases: pre-tender, tender, and post-tender (i.e., Ghezzi & Mikkonen, 2024; Holma et al., 2020). The public agency can also decide to use in-house procurement, meaning that the procurement is considered an internal production. In this situation, following the regulated public procurement procedures is not required, although in-house companies typically depend on public procurement when acquiring ICT solutions (Ghezzi & Mikkonen, 2024). The competitive negotiated procedure requires higher expertise on the buyer's side but is believed to lead to the best outcomes

[1] More information on the page "Public procurement legislation", Ministry of Economic Affairs and Employment of Finland https://tem.fi/en/public-procurement-legislation

[2] More information on the page "Public procurement", Suomi.fi https://www.suomi.fi/company/developing-the-business/marketing-and-sales/guide/sales/public-procurement

when purchasing completely new or otherwise complex systems (Ghezzi & Mikkonen, 2024). However, direct awards are usually emergency solutions used in vendor lock-in situations or with limited time (Ghezzi & Mikkonen, 2024). See more details about the procurement tasks and processes in Figure 1.

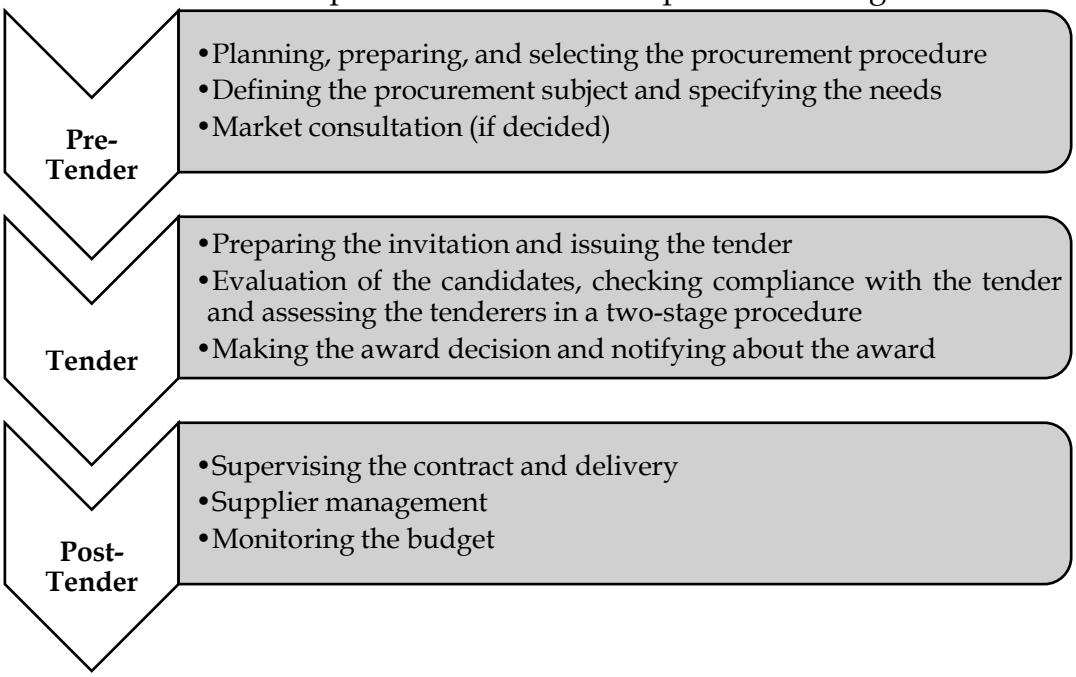

Figure 1 Procurement tasks and processes in Finland, adapted from Ghezzi and Mikkonen (2024) and the Handbook on Government Procurement (2023).

To wrap up the section, the public procurement process in Finland is heavily regulated by strict legal frameworks, including EU directives and national legislation, which can limit flexibility in adopting innovative solutions. Understanding these constraints is important for evolving procurement practices to better support the integration of software ecosystems in public service delivery.

2.1.2 Challenges and Suggested Solutions in the Public Service Delivery

The public procurement process involves several challenges that are present in the tendering phase, as outlined by Koski (2019). These key issues include maintaining clarity and consistency in documentation, effective communication, and building trust between the procurement unit and potential suppliers (Koski, 2019). Figure 2 introduces the challenges in more detail when preparing the tender, issuing the tender, awarding the contract, and finally closing the tender. The arrows demonstrate how these challenges extend further and affect procurement.

Executing the procurement process requires a lot of resources and expertise from public organizations. Holma et al. (2020) highlight the intermediary role of public procurement units between the service providers and internal stakeholders when aligning service specifications, particularly during preparing public procurement. The findings suggest that successful public-private collaboration requires structured, transparent processes to achieve optimal outcomes (Holma et al., 2020). Meaningful involvement could be, for example, market surveys,

information sessions and presentations, technical dialogues, and provider comment rounds. Despite it not being a mandatory step, a preliminary market consultation prior to announcing the upcoming tender allows the buyer to share the plans and discuss them with expert vendors (Ghezzi & Mikkonen, 2024; Riihimäki & Pekkola, 2021). This is beneficial for procurement since it may be impossible to adjust the requirements specified in the tendering documents in the later phases of the process (Ghezzi & Mikkonen, 2024), as also highlighted by Koski (2019). Building a cooperative mindset and balancing the conflicting interests of stakeholders could turn out to be a challenging task in the public sector's complex stakeholder environments. However, there are some successful cases where procurement units benchmarked and shared information with other public organizations to solve common pitfalls and shared challenges in acquiring ICT systems (Ghezzi & Mikkonen, 2024). Finally, when making decisions about the offers, the price has a high emphasis and is relatively demanding to erase from the selection criteria in practice in the Finnish procurement process (Ghezzi & Mikkonen, 2024).

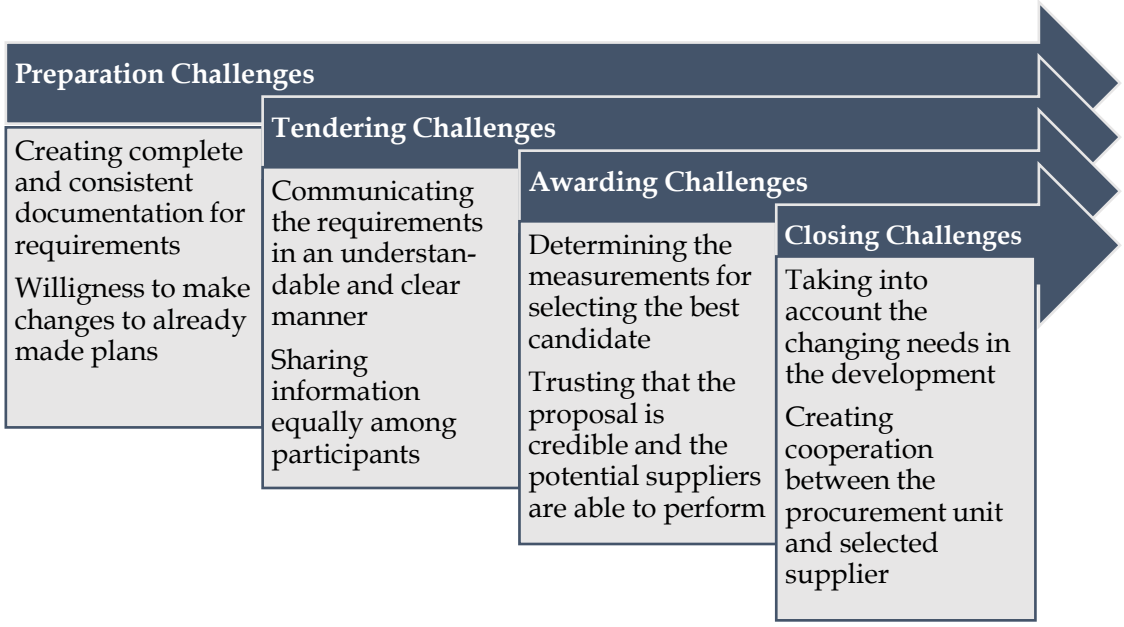

Figure 2 Challenges encountered in the public tendering phase, according to Koski (2019).

Acquiring public ICT systems and solutions enables modernizing the government and increasing its efficiency, improving internal operations and structures, and, finally, building engagement between the government and the public by increasing access, convenience, and effectiveness of public service delivery (Janowski, 2015). However, these service digitalizing efforts are often localized, and the systems are developed independently (Janowski, 2015). While this provides some local benefits, it leads to inconsistent and unequal services on the national level. Due to different local practices, skills, and differing local digital environments, the attempts to harmonize digital transformation face recurring challenges (see, for example, Fagnot et al., 2018; Pekkola et al., 2022). The Digital Government Evolution Model developed by Janowski (2015) suggests supporting

local efforts and communities pursuing their specialized initiatives. However, this demands public efforts to enable steady technology adoption, build trust and change cultural attitudes, increase participation, and, finally, manage transparency, accountability, and open government (Janowski, 2015).

Adopting better Enterprise Architecture practices could potentially enable more efficient and sustainable software management across the public sector by enhancing the integration and interoperability of public services (Nurmi, Seppänen, et al., 2019; Setälä et al., 2021). Enterprise Architecture is mandatory in the Finnish public sector when acquiring ICT solutions. It provides a structured framework for managing complexity, aligning organizational goals, and facilitating transformation to more adaptive operations in the public sector (Niemi & Pekkola, 2020; Nurmi, Penttinen, et al., 2019). Despite the mandatory status, the Enterprise Architecture adoption rates and maturity are generally low (Seppänen et al., 2018). A recurring issue is the fragmented nature of public sector operations, where each organization tends to operate in silos, making independent procurement decisions (Setälä et al., 2021). Partly, the challenge is in the long-term realization of the Enterprise Architecture benefits that require maintaining focus and measuring progress (Niemi & Pekkola, 2020), further complicated by the resistance to Enterprise Architecture partly due to unclear goals, inconsistent coordination practices, and poor communication (Rouvari & Pekkola, 2024; Seppänen et al., 2018). Moreover, the complexity of the public sector operating environment and stakeholder networks make it hard to manage the Enterprise Architecture and require rethinking the practices and frameworks (Nurmi, Penttinen, et al., 2019; Nurmi, Seppänen, et al., 2019).

To conclude, the traditional organizational culture and resistance to change observed in the public sector can create obstacles to the adoption of agile practices. Public procurement in Finland faces challenges such as maintaining clarity and consistency in documentation, effective communication, and building trust between procurement units and suppliers. Addressing these challenges through better market consultation and collaboration can improve the procurement process and support more agile methods while maintaining the stability and predictability that are essential to their operations.

2.1.3 Public-Private Collaboration in the Public Service Delivery

Collaboration with the private sector adds complexity to public service delivery, particularly in terms of integrating different systems and processes. In order to follow the public procurement principles, such as transparency, equity, and non-discrimination (Procurement Directive, EU, 2014), buyer and supplier interactions need to be kept formal and procedural in the actual tendering phase (McKevitt & Davis, 2015). On the other hand, there is a need for meaningful collaboration among the public and private participants (Holma et al., 2020).

Each of the procurement phases requires collaborative practices for stakeholders, at least to some extent (Ghezzi & Mikkonen, 2024; Holma et al., 2020), even if the interaction is typically most active in the pre-tender phase without as strict legislative constraints (McKevitt & Davis, 2015). Vendors have expressed

that preliminary communication, especially informal discussions, is highly valuable in understanding the system needs and, thus, supports acquiring ICT systems effectively (Ghezzi & Mikkonen, 2024). Concurringly, early and continuous engagements allow private sector expertise to inform service design, further fostering more innovative and effective solutions (Holma et al., 2020). Especially buying new or complex systems requires a higher level of expertise in the procurement unit, open communication with vendors, and other resources to map out the system's long-term needs in the necessary detail (Ghezzi & Mikkonen, 2024). In these cases, the competitive negotiated procedure is most beneficial (Ghezzi & Mikkonen, 2024). However, early interaction is not always possible despite the expressed and recognized benefits. Limited resources constrain the early discussions with the vendors (Ghezzi & Mikkonen, 2024).

Attitudes and experience in the tendering process can set the procurement process to success or failure. Riihimäki and Pekkola (2021) investigate the concerns that influence public buyers during the early phase of the procurement process, more precisely, the preliminary market consultation phase. They identified, for example, doubts about the solution security in handling sensitive data and skeptical attitudes towards whether the vendors' solutions truly meet the specific needs or lack necessary customization. Further, past experiences with delays, cost overruns, and underperformance created mistrust regarding vendor reliability and credibility. According to the study, these early concerns can have long-lasting impacts on the procurement process, affecting the system requirements and vendor selection (Riihimäki & Pekkola, 2021). Similarly, other studies have recognized the tensions that arise from the lack of trust and misaligned incentives between buyers and vendors. Holma et al. (2020) emphasize the importance of knowledge-sharing, routines, successful collaboration experiences, and trust-building in lowering the perceived risks in the early phase of procurement. Ghezzi and Mikkonen (2024) highlight the potential for public organizations to utilize installments and fines to manage their relationships with vendors. This, in turn, may result in vendors seeking to implement expedient solutions that may not necessarily align with the objective of achieving good quality outcomes.

In addition to external stakeholder involvement, there is a need for internal collaboration in public organizations. However, public organizations share different capabilities, resources and experiences with digital service development. A Pekkola et al. (2022) case study describes the service standardization attempt to develop Suomi.fi platform for citizen-civil servant messaging. The project was initiated by the government and co-tailored by a consortium of eight municipalities. They recognized several resource disparities, communication gaps, integration issues, and legal challenges during the collaborative endeavor (Pekkola et al., 2022). For example, smaller municipalities struggled to continue development after the project ended, while some could push for advanced features. Lack of insight into each other's progress and decisions led to inconsistent implementation and local solutions. Private companies participating in the development project did not have incentives to align their systems with the government platform, leading to integration issues. The efficiency and uniformity of the project were

further hindered by slow development that reduced general interest in the project and the absence of common guidelines that raised questions about possible legal complications (Pekkola et al., 2022).

Collaboration evolves over time in longer-term system development. Molander et al. (2021) identify four distinct collaboration modes in large-scale enterprise systems development projects: contractual, cooperative, personified, and process modes, each of them characterized by different drivers and outcomes, as presented in more detail in Table 1. The shifts between modes happen in response to project-specific incidents, such as technological crises or organizational changes, reflecting the dynamic nature of collaboration in such complex environments (Smolander et al., 2021). For example, a project may start with a contractual mode focused on formal agreements and predefined roles, but as it progresses and faces unexpected issues, there may be a need to shift to a cooperate mode that emphasizes mutual interest and voluntary cooperation to navigate the challenges. Alternatively, when urgent problem-solving is required, the project may make a shift towards a personified mode that relies on the expertise and decision-making abilities of key individuals. These shifts are not linear or predictable, which further highlights the complex nature of managing collaboration in large-scale projects (Smolander et al., 2021), especially in environments where flexibility is constrained by strict regulations, hierarchical structures, and complex stakeholder networks (Nuottila et al., 2016).

Table 1 Four modes of collaboration in long-term system development projects, following Smolander et al. (2021)

Mode of Collaboration	**Contractual Mode**	**Cooperative Mode**	**Personified Mode**	**Process Mode**
Definition	Based on legal contracts that clearly define roles and responsibilities between the parties involved	Based on mutual interests and voluntary cooperation, focusing on shared goals	Centered around key individuals who delegate responsibilities, recognize expertise and build trust	Determined by established processes that define how parties interact and how procedures are carried out
Emphasis	Formal plans and commitments	Cooperative actions and fostering a collective spirit, "us"	Individual contributions and achievements	Change management and the continuous improvement of processes
Requires	Clear, legally binding contracts	Common goals and solutions that are beneficial solutions to all involved parties	Involvement of influential individuals who can drive the collaboration	Well-defined and implemented processes
Purpose / Problem Solved	Addresses issues related to the division of	Addresses situations where there is a lack of	Responds to the need for immediate problem-solving.	A structured approach to continuous

	costs and responsibilities.	clarity or shared understanding.	planning and quality management.

In conclusion, effective public-private collaboration is a critical aspect of modern governance, yet it is often constrained by regulatory rigidity and procedural constraints. Early engagement and continuous communication between the public and private sectors can facilitate the development of more innovative and effective solutions, especially in the context of complex or novel systems.

2.2 Agility and Change in Public Organizations

The increasing pace of technology and the increasing complexity of systems are part of today's business environment reality. The instability in the business environment is leading to uncertainty and accelerating market cycles. In order for organizations, public as well as private, to operate in this environment of constant motion, they need to be equipped to cope with increasing changes (Dove, 2002; Sharifi & Zhang, 2001). This section will look into the characteristics of an agile organization in general and in the public sector. In the context of this thesis, understanding what agility involves further supports evaluating how software ecosystems can provide the necessary flexibility without compromising public service stability. Furthermore, the section examines how to enable organizational change in public settings.

2.2.1 Introducing Agile Organizations

Becoming an agile organization encompasses the ability to sense changes and then quickly react to them, turning the situation into a competitive advantage (Sharifi & Zhang, 2001). Today, organizations are increasingly turning to information technology to support their ability to respond to threats and opportunities (Tallon et al., 2019). The phenomenon has been researched for more than three decades, and the term "*agile*" was born in a governmental research project looking into improving manufacturing processes led by Rick Dove in 1991. Due to its background, agility initially carried a manufacturing focus. Figure 3 visualizes the difference between flexibility and agility in the context of manufacturing business structures. Agility can be seen to extend flexibility and adaptability by including speed and scope in terms of rapidly responding to changing conditions and quickly delivering solutions (Mathiassen & Pries-Heje, 2006; Sharifi & Zhang, 2001). Growing out of the manufacturing industry, the interpretation of agility became more fundamental; it is understood as a vital business strategy or a business competency for competitive advantage (Dove, 2002; Sharifi & Zhang, 2001), especially in the world of fast-paced technological advancements (D. J. Teece, 2007).

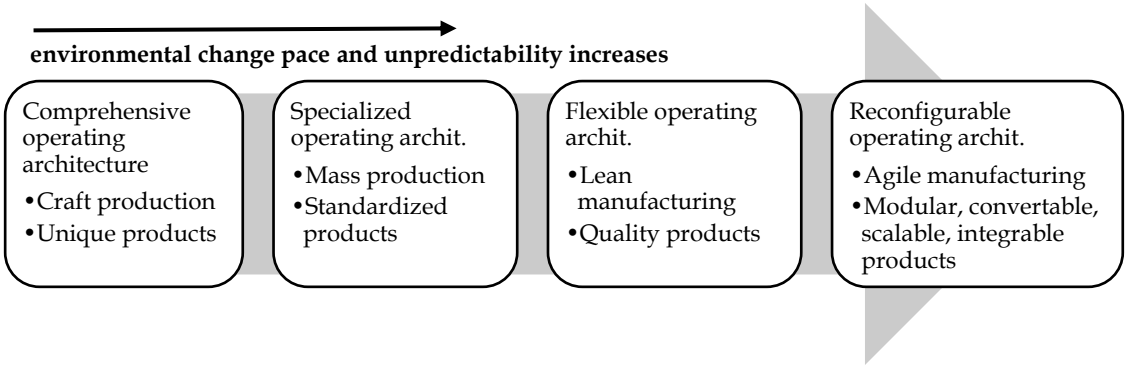

Figure 3 Agility on the continuum of manufacturing paradigms[3]. Adapted from Dove (2002).

According to Dove (2002), the capacity to transform needs to be built into the organizations so that it becomes natural and continuous. The organization's agility depends on two core abilities: The "physical" ability to act and the intellectual ability to find the appropriate things to act on. First, the organizational structure needs to enable change. In practice, reusable, reconfigurable, and scalable procedures, systems, frameworks, components, etc., need to be in place to enable higher organizational adaptability. To drive the transformation, the organization needs commitment from stakeholders, and thus, the organizational culture is a facilitating force in making the change a reality. Dove (2002) sees change proficiency as a dynamic competency that could manifest itself, for example, in the form of rules, principles, and a shared mindset, depending on how mature the organizational culture around the change is. Fundamentally, it is rooted in the beliefs and values of the organization. The second, intellectual ability, indicates that organizations need to be able to manage and apply strategically important knowledge effectively (Dove, 2002). Moreover, in Dove's model, collaborative learning is an integral part of knowledge management, demanding both cultural and infrastructural support in the organization (Dove, 2002).

Teece et al. (2016) criticize agility as having become an immutable quality expected from an organization. They argue that being in a state of constant transformation is too costly and disadvantageous for sacrificing efficiency. They suggest organizations put emphasis on developing their dynamic capabilities to support recognizing "when (and how much) agility is needed" (D. Teece et al., 2016). The concept of dynamic capabilities was introduced by Teece et al. (1997), emphasizing the importance of the business's ability to integrate, build, and reconfigure internal and external competencies. Building on their earlier research, Teece (2007) further refined the dynamic capability framework by outlining the specific processes of sensing, seizing, and reconfiguring assets, as described in Table 2. The table gives an idea of how challenging building such capabilities might be within the resources of a single organization.

[3] Since then, new manufacturing paradigms have emerged, and sustainable production, smart manufacturing, and data-driven smart manufacturing are some of the driving forces in these advancements. See, for example, Griffiths (Griffiths, 2012), Moghaddam et al. (Moghaddam et al., 2018) and Tao et al. (Tao et al., 2018).

Table 2 Dynamic capability processes, according to Teece (2007) and updated by Priyono and Hidayat (2024)

CAPABILITY	ACTIVITIES	EXAMPLES
Sensing opportunities and threats by identifying and assessing them	Acquiring real-time insights and identifying shifts in customers' preferences.	Research and development activities, co-innovation, identifying changing customer needs, continuous market positioning, transparent communication, etc.
Seizing opportunities through mobilizing resources and capitalizing on the identified opportunities	Trial and error knowledge integration and broadening innovation networks.	Selecting fitting decision-making protocols, building loyalty and reflecting the customer needs to business model, learning and capturing knowledge, promoting market engagement, etc.
Reconfiguring assets (or transforming) to maintain a competitive advantage	Executing change and contributing to the business environment and ecosystem trends in order to renew and adapt.	Selecting fitting decision-making protocols, fostering a learning culture, developing product prototypes, building loyalty, and reflecting the customer needs to business model, etc.

Finally, the successful integration of new technologies and the development of dynamic capabilities, as discussed by Teece et al. (2016) and Pisano (2017), are essential for agility. Enhancing the organization's capabilities always requires top-down coordinated investments and efforts, which are affected by factors like management, organizational processes, and resource allocation, to mention a few (Pisano, 2017). However, building a set of dynamic capabilities requires significant investments in time, resources, and training while there is growing pressure to streamline IT operations and limit spending, leaving the organizations to face a difficult decision (Tallon et al., 2019). Despite the challenges, public organizations must aim to build reconfigurable and scalable processes, systems, and frameworks to enhance their adaptability while balancing stability.

2.2.2 Implementing Agility to Public Service Delivery

The capacity for agile service delivery allows for more rapid response times to internal and external changes, the potential for more personalized services, and the ability to rapidly scale solutions. However, the unique characteristics of public organizations, such as strict legislative requirements and complex stakeholder environments and software architectures, lead to additional difficulties in adopting agile methods compared to the private sector (Nuottila et al., 2016).

Agility was introduced to the software engineering domain as a new development method for quickly adapting to changing system requirements and quickly delivering the product. The Agile Manifesto (2001) represented a shift in software development philosophy, emphasizing innovation and responsiveness in a rapidly changing environment. It promoted adaptive planning, evolutionary development, early delivery, and continuous improvement. The following four principles were the core of the manifesto (Fowler et al., 2001):

1. Individuals and interactions over processes and tools.
2. Working software over comprehensive documentation.
3. Customer collaboration over contract negotiation.
4. Responding to change over following a plan.

A detailed case study on a large Finnish government agency conducted by Nuottila et al. (2016) identified and categorized several challenges to following these principles in public sector IT projects. While adopting agile practices led to notable improvements in efficiency and transparency, the development project faced challenges with the lack of documentation, education, and commitment of personnel, stakeholder communication, role definitions within the agile setup, the physical location of agile teams, legislative constraints, and the complexity of software architecture and system integration (Nuottila et al., 2016).

To bring up a few examples also discussed by Nuottila et al. (2016), Finland's Public Procurement Act regulates what data can be shared with stakeholders and restricts vendor selection so that past partnerships cannot put a vendor in a favorable position despite the agile method being based on trust and good dialogue. In some cases, the regulatory constraints could even lead to "procurement theater," where formal processes are followed even when the outcome has been informally decided (Ghezzi & Mikkonen, 2024), limiting flexibility and hindering innovation. Further, flexible changes allowed by agile methods make it difficult to keep a complex web of stakeholders informed, and involving, for example, users in planning becomes burdensome with incremental planning and release (Nuottila et al., 2016). However, the case study concluded that increased productivity and decreased (even up to 25%) administrative work enabled the agency to develop more digitized services with their limited budget compared to traditional software development (Nuottila et al., 2016).

Thus, agile methods in public service delivery can lead to improved efficiency and transparency but face challenges such as legislative constraints, complex stakeholder environments, lack of commitment and expertise, as well as integration difficulties. Despite these challenges, adopting agile practices can significantly enhance the responsiveness of public services.

2.2.3 Enabling Change in Public Organizations

Implementing agility requires changes in organizational culture, processes, and structures. However, making these changes is complex and rarely a linear process. There are numerous models for organizational change, each with a distinct focus. For instance, models may focus on the importance of managerial skills, the organizational ability to implement change, employee adaptation, and more (Errida & Lotfi, 2021). One of the foundational approaches for organizational change is Kotter's (1996) 8-Step Process for Leading Change. This model includes aspects of ICT system development, cooperative social systems, and power dynamics as factors that influence change. Kotter (1995) points out the need for leadership, vision, and employee involvement. To create a clear change process engaging and empowering employees, the organization needs to

1. establish a sense of urgency,
2. build support,
3. develop a change vision,
4. communicate the change vision,
5. empower and enable action,
6. generate short-term wins,
7. consolidate and revitalize change, and
8. anchor new approach in culture.

Kuipers et al. (2014) provide key aspects of managing change in public organizations. First, leadership is identified as a crucial driver of successful change, emphasizing that leaders need to be adaptive and credible, especially in public sector contexts where political and administrative leadership often overlap. The authors stress the importance of taking into account contextual factors, such as political influences and stakeholder networks, making public sector change more complex than private organizations. They also point out that change processes in public organizations often require a balance between planned and emergent strategies, depending on the scale and urgency of the change. According to Kuipers et al. (2014), public sector organizations have a requirement to stay accountable and transparent, which challenges flexibility to experiment with new approaches or make changes quickly, and thus, justifying actions and decisions publicly makes change management more complex.

In today's organizational landscape, change is often intertwined with digital transitions. Digital transitions in service delivery require complex resource integrations and some level of centralized oversight and integration (Sklyar et al., 2019). To address these challenges, organizations should first support strategic change initiatives that align their internal processes with their digital goals (Sklyar et al., 2019). Creating close interactions with external and internal parties, clarifying the vision, building trust with open information sharing, and centrally ensuring that each part of the organization has high enough IT competency and necessary digital tools and resources available are some of the activities that support digitalizing services (Sklyar et al., 2019). Employees' and management's mindsets need to change to facilitate such changes. A recent study on enabling digital servitization by Kowalkoswki et al. (2022) demands visionary leadership, top-down support for cultural change from planning to discovery, and abandoning the silo mentality and leaning towards fostering partnership instead. Creating collaboration and making joint activities appealing to different parties, there is a need to align value propositions and create clear benefits for all parties (Kowalkowski et al., 2022).

To conclude, successful implementation of agility requires changes in organizational culture, processes, and structures. Leadership, clear vision, and employee involvement are critical factors in driving change, while public sector organizations must overcome their traditional hierarchical approaches to become more dynamic and adaptive.

2.3 Ecosystem Approach in the Public Sector

Organizations need to collaborate increasingly to be able to navigate in a rapidly changing business environment. Ecosystems are dynamic and interconnected networks where multiple participants cooperate to create and sustain a competitive edge (Basole et al., 2015). Understanding ecosystems in the context of the public sector makes it possible to assess how they can be leveraged to improve public service delivery. The ability of ecosystems to enhance organizational agility is widely recognized (Moore, 2006). This section will provide an understanding of how software ecosystems function to improve public service delivery. The first part introduces general ecosystem dynamics and governance after which the core components of software ecosystems will be explained in more detail.

2.3.1 Ecosystem Dynamics and Governance

Adopting an ecosystem perspective enables public procurers to optimize resource use, connect with business innovations, and amplify their impact. A business ecosystem is a network of organizations, individuals, and entities collaborating to create value through the distribution of goods and services (Adner, 2017; Iansiti & Levien, 2004). It includes various actors—suppliers, customers, regulators, and other stakeholders—who occupy specific roles within the network. These actors are interconnected, so changes in one part of the ecosystem can trigger ripple effects throughout (Peltoniemi & Vuori, 2004). A key feature of business ecosystems is their flexibility and adaptability, allowing them to respond effectively to external changes (Moore, 2006).

To navigate these complex settings, organizations must commit to shared objectives, transparent decision-making, and collaborative risk and value-sharing rather than focusing solely on controlling their own resources (Dattée et al., 2018). Ecosystems facilitate the flow of transactions, information, talent, and financial resources (Basole et al., 2015). In order to take part in such co-creation of value, organizations need to adopt a more holistic, cooperative approach (Moore, 2006) and a dynamic mindset (D. J. Teece, 2007). This can involve, for example,

- enhancing integrability and standardization (Sklyar et al., 2019),
- open and adaptive resource integration (Kowalkowski et al., 2022; Sklyar et al., 2019),
- establishing common goals and compatible incentives (Adner, 2017),
- improving agility (Dattée et al., 2018) and mutual compatibility (Adner, 2017),
- fostering partnerships and healthy competition (Iansiti & Levien, 2004; Moore, 1993), and
- collaborative value creation through, e.g., innovation (Wang, 2021).

Ecosystem development is one of the key priorities for responsible procurement in Finland[4]. Although the concept of a business ecosystem has been around for over 30 years (Moore, 1993), it is relatively new to the government and policy-makers in Finland (Rinkinen & Harmaakorpi, 2018). Traditionally, the public sector's role has been viewed as supportive in fostering commercial business ecosystems (Rinkinen & Harmaakorpi, 2019), rather than being a central partner. This hesitance is partly due to ecosystems' holistic and dynamic nature, which requires organizations to shift from structured, hierarchical approaches to more flexible, collaborative models. Unlike networks and clusters, the ecosystem approach demands changes in structure design and value creation (Basole et al., 2015; Dattée et al., 2018). Public organizations, typically more accustomed to rigid frameworks, often struggle to adopt dynamic ways of working (Nuottila et al., 2016). However, studies suggest that the government has a critical role as the driving force of change here (Kuipers et al., 2014), guiding the vision for both immediate and long-term needs in close partnerships with the private sector (Cojoianu et al., 2020). Achieving this shift requires new tools and a mindset change to build effective collaboration with organizations that work differently. In order to successfully share resources within the ecosystem, organizations must consider strategic and social factors, stay aware of industry trends, and invest in internal management (Eisenhardt & Schoonhoven, 1996).

Ecosystems are not static; they are dynamic, self-organizing entities driven by the interdependencies and co-evolution of their participants (Basole et al., 2015). To maintain stability in the face of constant change, organizations must commit to ongoing learning, adaptation, and mutual feedback (Cristofaro & Lovallo, 2022). Understanding the governance of ecosystems is crucial for organizations aiming to thrive in rapidly changing environments. Ecosystem governance involves developing, managing, and controlling shared processes, models, and rules that enable ecosystem formation (Laatikainen et al., 2021). However, designing and developing such a multi-directional, dynamic, complex system is a challenging process (Lankhorst, 2004). To ensure ecosystem success, Dattée et al. (2018) propose a strategic, feedback-driven process that includes roadmapping and preemptive planning, enabling organizations to steer the ecosystem in a proactive and sustainable direction. Coskun-Setirek et al. (2023) emphasize that aligning architecture with governance is key to an ecosystem's success. While architecture defines the structure and interactions, governance ensures coordination and control. Figure 4 introduces the key factors to consider when designing a balanced ecosystem architecture and governance. Misalignment between the two can lead to inefficiencies and conflicts, potentially threatening the ecosystem's stability (Coskun-Setirek et al., 2023). In successful ecosystems, efficient structures support innovation, while governance provides the control and flexibility needed to manage the system's complexities and dynamics (Coskun-Setirek et al., 2023).

[4] More about the objectives to build sustainable and innovative procurement practices in Finland, Ministry of Economic Affairs and Employment of Finland www.tem.fi/en/keino-en

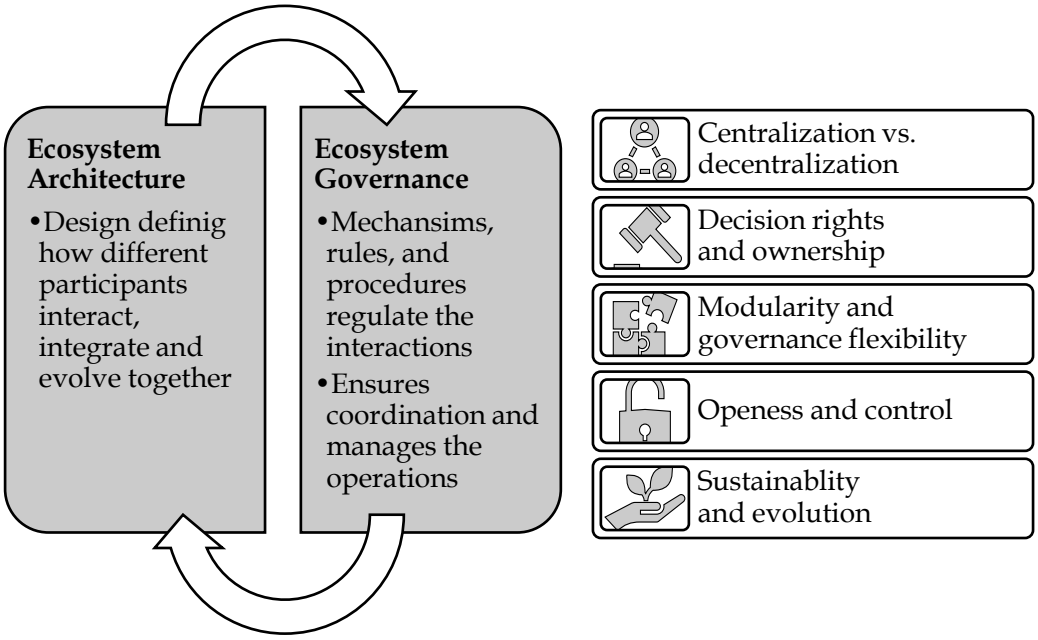

Figure 4 Aligning the digital ecosystem architecture and ecosystem governance, according to Coskun-Setirek et al. (2023)

Adopting an ecosystem perspective enables public organizations to enhance resource utilization, connect with business innovations, and improve their impact. Proper alignment between ecosystem architecture and governance is essential to manage the complexities and ensure the success of software ecosystems in public service delivery. Ecosystems have the potential to improve efficiency, effectiveness, and responsiveness in public service delivery.

2.3.2 Core Components and Evolution of Software Ecosystems

A software ecosystem revolves around a central platform or set of related technologies, enabling the exchange of information, resources, and innovations among participants. It provides an infrastructure for collaboration, with developers contributing to core platforms and extensions, facilitating market expansion and innovation through new products and partnerships (Jansen et al., 2009). Ecosystems promote resource sharing and reuse, allowing participants to build on each other's work (Jansen, 2014), which necessitates clear guidelines on software reuse, buy-versus-build decisions, and access to knowledge bases. These ecosystems also foster knowledge exchange and community building, ensuring long-term sustainability through shared expertise and best practices (Jansen, 2014; Jansen et al., 2009).

In the public sector, procurement is the key avenue for introducing software ecosystems. These ecosystems enable public organizations to respond more effectively to changes in public needs, technological advancements, and policy shifts. They provide a holistic view of public service delivery, recognizing that changes in one area can have ripple effects throughout the system. For example, changes to Application Programming Interfaces (APIs) can cause widespread

effects across an ecosystem, taking months to fully spread across the system (Robbes & Lungu, 2011). This is particularly relevant in the public sector, where complex ICT solutions rely on interconnected components and interfaces managed by different actors (Nuottila et al., 2016). Managing ripple effects is a significant challenge, especially in large-scale, multi-actor ecosystems.

Forming ecosystems has long been a natural fit for the software and IT industries, where close digital partnerships allow for better risk sharing, access to synergistic knowledge, and quicker responses to changes in the business environment (Basole et al., 2015). Nurmi et al. (2019) suggest that public sector organizations should also be managed as ecosystems, requiring a holistic approach to architecture management. Their research highlights challenges such as lack of transparency, the need for continuous updates, and difficulties in managing cross-organizational relationships and data sharing. A comprehensive approach to ecosystem management is needed in the public sector, emphasizing openness, modularity, and co-evolution among participants. The government plays a key role in supporting problem-solving and discovering new opportunities within these ecosystems (Cardoso et al., 2013).

Wrapping up the section, software ecosystems facilitate collaboration, resource sharing, and innovation in public service delivery. The objective of software ecosystems is to create, maintain, and support software platforms or applications. These ecosystems integrate the technical and social aspects of software development and deployment.

3 SUMMARY OF THE ARTICLES

In this section, I introduce and summarize the two primary articles, including my contribution to the articles, and their research design. There are sections detailing the articles' research problems and discussing their findings from the perspective of the thesis. Further, I shortly introduce a research tool, Ecosystem Governance Compass, that I have been using and developing alongside conducting the studies.

Both articles focus on developing software ecosystems within Finland's public sector and explore their impact on public service delivery. Balancing stability and agility in public service delivery is a complex challenge, requiring careful consideration of multiple factors. The articles provide different use cases for reflecting the requirements for balance and agility, deriving practical implications for public sector ICT procurement from expert interviews. There are significant similarities between the two publications, as both concentrate on ICT system acquisition and development projects based on public tenders. The research gains a timely and intriguing perspective by shifting the focus toward the formation of software ecosystems. This provides the context for the research presented in this thesis.

The findings from the articles offer valuable insights into how software ecosystems can be used to improve public service while maintaining this balance. Figure 5 presents stability and agility factors derived from the two use cases. Although the articles approach these factors from different perspectives, several are shared. Together, these factors create a framework that supports effective and sustainable public service delivery in a dynamic, evolving environment.

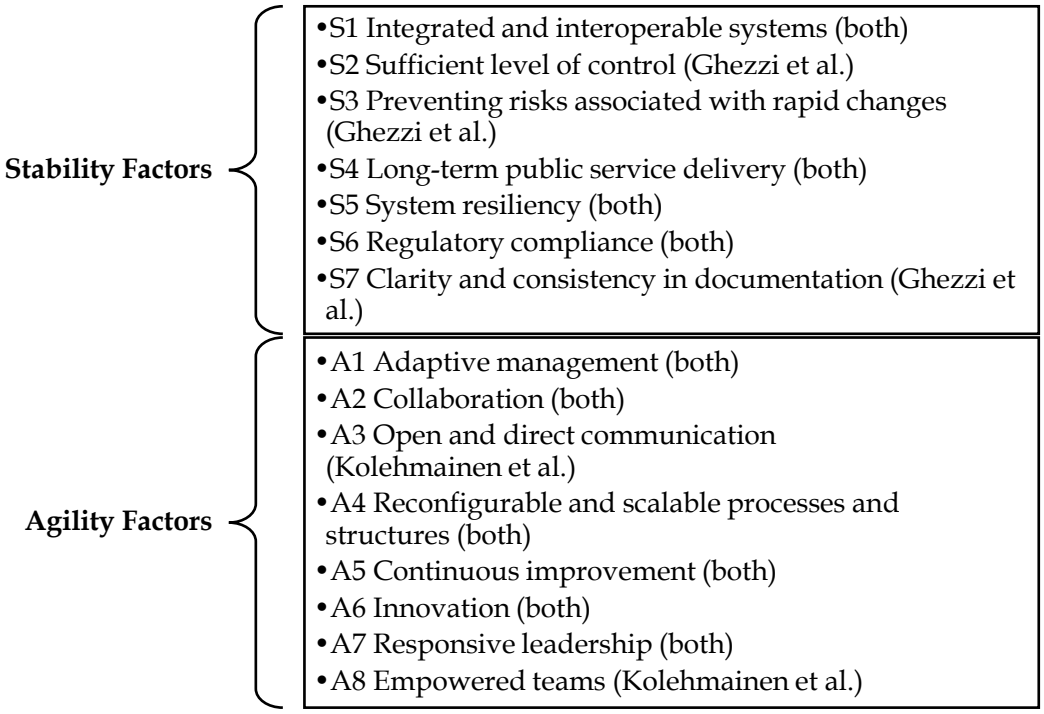

Figure 5 Stability and agility factors collected from the primary articles

3.1 Research Tool Used in the Articles

The Ecosystem Governance Compass is a domain-specific modeling language that enables visual modeling. Domain-specific modeling languages incorporate familiar domain concepts to create abstract, understandable, accurate, and predictive models (Selic, 2003). The tool offers a visual representation of ecosystem components, stakeholders, interactions, and dependencies within the context of digital, technology-enabled ecosystems. These visual models facilitate alignment among stakeholders on ecosystem structure and collaboration, thereby enabling detailed and accurate communication and decision-making (Sroor, 2022).

The tool provides a set of shared domain concepts that enable stakeholders to discuss the system under development in a clear and accurate manner, ensuring that communication is both understandable and effective. The Ecosystem Governance Compass language concepts are derived from literature and based on a holistic, dynamic, system-based view of collaborative ecosystems by Laatikainen et al. (2021). The language objects are divided into four categories representing different aspects of ecosystem governance: governance, business, technology, and legal and regulatory context. An example of a governance graph modeled with the tool in Figure 6.

The tool supports informed strategic decisions for practitioners and support analyzing and exploring a complex ecosystem via knowledge integration (Mader et al., 2008). The models provide a systematic and structured foundation for developing an ecosystem governance framework. The tool is currently developed

in the Faculty of Information Technology at the University of Jyväskylä. The prototype is implemented on the MetaEdit+ platform for domain-specific modeling.

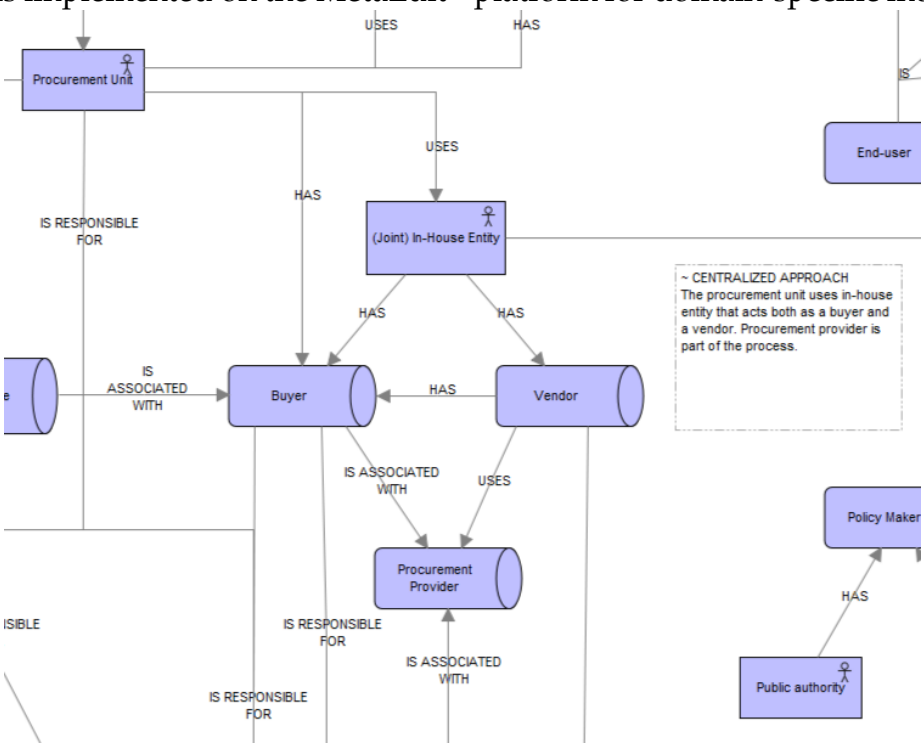

Figure 6 A governance graph modeled with the Ecosystem Governance Compass

3.2 Article I: Unifying a Public Software Ecosystem: How Omaolo Responded to the COVID-19 Challenge

The first paper, *"Unifying a Public Software Ecosystem: How Omaolo Responded to the COVID-19 Challenge,"* by Kolehmainen, Ghezzi, Hyrynsalmi, Mikkonen, Pekkola, and Setälä (2024) describes the rapid development of the Omaolo system during the COVID-19 pandemic. It details the shift from traditional collaboration models to a more integrated, agile "alliance model." This new approach allowed the ecosystem to respond effectively to external shocks, enhancing its flexibility, adaptability, and resilience and enabling healthcare solutions' rapid development and deployment. The manuscript is submitted to a practice-oriented special issue.

3.2.1 Contribution to the First Article

As the first author, I had a large role in designing, conducting, and reporting the study findings presented in the first paper by Kolehmainen et al. (2024). I participated in forming the research question and objectives for the study and in discussions to refine the research focus along with other experienced team members. My contributions included mapping out the research context, identifying possible gaps, and suggesting specific objectives. I also conducted a literature review,

identifying key themes and gaps related to software ecosystems and public-private collaboration. My focus was particularly on ecosystem dynamics and governance, including the nuances of public-private collaboration. Additionally, I reviewed all the background information documents related to the Omaolo platform to ensure an understanding of the use case.

In the phase of data collection, I crafted the structure and questions for the interviews in collaboration with my colleagues, relying on my expertise in ecosystems to enhance the likelihood of acquiring meaningful insights into ecosystem governance and dynamics. Despite not conducting the interviews myself, my design assisted in directing the data collection process. I was responsible for the data analysis in most parts, using the Ecosystem Governance Compass, a domain-specific visual modeling tool, to map the ecosystem. This included understanding the previous governance approach, analyzing the new approach, and comparing both based on themes identified in the literature. The analysis focused on how the ecosystem evolved during the pandemic.

During the manuscript preparation and project management, I contributed to writing and finalizing the manuscript, particularly focusing on the sections related to ecosystems, research methods, findings, and discussion. Additionally, I organized meetings to discuss the progress of the manuscript, collected feedback from advisors, peers, and the research partner, and incorporated this feedback into the manuscript. Additionally, I managed the response to the reviewers' feedback and wrote the response letter. My project management tasks included overseeing timelines, coordinating communication between authors, and ensuring that all aspects of the study were aligned.

One challenge involved addressing concerns about the practical implications of the results, as the publication forum emphasized practicality. To improve this aspect, I plan to make the before-and-after comparison in future work.

3.2.2 Research Design in the First Article

The article by Kolehmainen et al. (2024) adopts a case study approach, focusing on the evolution of the Omaolo platform from 2020 to 2022. This study aims to examine how the platform, which serves as an e-health service in Finland, adapted to the challenges presented by the COVID-19 pandemic. To gain insights into the Omaolo ecosystem, the research team conducted nine semi-structured interviews with key stakeholders, including project leads, medical directors, portfolio managers, and senior software engineers from public sector entities, private vendors, and medical experts. The interviewees' roles and the key topics discussed during these sessions are detailed in Table 3.

In addition to the interviews, the study involved a thorough review of publicly available documentation, such as project reports, which provided a broader historical and contextual understanding of the platform's development. This review helped us ask specific questions during interviews and place expert responses within the project's broader context. The interviews covered a range of themes, including governance, cooperation, technological innovation, and regulatory compliance. The findings highlighted critical changes in participant

dynamics that occurred during the pandemic. The key interest was in participant incentives, aligned development, and business objectives. The interviews were recorded, transcribed, and analyzed to identify common themes and ecosystem interactions.

The use of the Ecosystem Governance Compass, a domain-specific modeling language, supported the analysis of the collected data. This tool was fundamental for understanding the interactions and dependencies among the various participants in the ecosystem, enabling the visualization of governance structure. The application of this modeling language facilitated a systematic exploration of the ecosystem's evolution, offering insights into how the platform's alliance model enabled its rapid adaptation in response to the crisis.

Table 3 Interview subjects, background, recording duration, and key topics listed, article I

Organization Type	Participant Role	Rec (min)	Key Topics
Private Sector, Vendor	Project Lead, Designer	63	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
Public Sector, Healthcare Providers	Medical Director	54	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
Public Sector, Ecosystem Coordinator	Medical Director	54	Governance, COVID-19 response
Public Sector, Ecosystem Coordinator	Portfolio Manager	82	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
Private Sector, Vendor	Senior Software Engineer	74	Values, Cooperation, Technology
Public Sector, Ecosystem Coordinator	Head of Operations	36	Business, COVID-19 response
Public Sector, Healthcare Provider	Senior Software Engineer	61	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
Non-Governmental Organization, Content and Knowledge Provider	Development Manager	49	COVID-19 response

The key findings from the article provide insights into the transition from conventional collaboration structures to a more integrated and agile "alliance model", which enabled the ecosystem to adapt to external disruptions swiftly. This showcases how public sector organizations can preserve their core stability while integrating the necessary flexibility to respond to rapidly evolving demands. The findings demonstrate that a collaborative and flexible approach can effectively navigate the tension between these competing needs in public service delivery, providing a practical framework for achieving both stability and agility within public sector software ecosystems.

3.2.3 Research Problem

The study explores how public sector software ecosystems can adapt to external shocks, such as pandemics, while maintaining efficiency and resilience in service delivery. Public healthcare organizations often face regulatory constraints, lengthy procurement processes, and siloed operations, which hinder their ability to respond effectively during crises. The Omaolo case study highlights the limitations of traditional, hierarchical software development and collaboration models in keeping up the pace of rapidly evolving service demands.

The research investigates the advantages of transitioning from a rigid, structured approach to an alliance-based model in public-private collaboration, specifically in enhancing service delivery during emergencies. The previous model, characterized by inflexible contracts, slow development cycles, and risk-averse governance, proved inadequate during the pandemic. The study examines how the alliance model, with shared objectives, flexible governance, and transparent communication, enabled the Omaolo ecosystem to adapt quickly and deploy essential healthcare services, preventing potential healthcare system overload.

The research offers insights into how public sector software ecosystems can become more responsive, resilient, and collaborative when faced with unexpected challenges. The study also provides lessons for future public-private partnerships and similar software initiatives.

3.2.4 Findings in the First Article

The Omaolo use case study by Kolehmainen et al. (2024) highlights how software ecosystems can balance stability and agility in public service delivery, particularly during crises. The Omaolo project evolved from fragmented systems to a more integrated, flexible ecosystem, enabling faster decision-making and problem-solving, which traditional approaches struggled to accommodate.

Agility factors. One critical factor was the shift in governance structures. Initially, the platform was governed by centralized control, slowing the ecosystem's pandemic response. As the situation progressed, the need for *adaptive management* (A1) became clear, leading to a more fluid, flexible distribution of responsibilities and quicker decision-making aligned with strategic goals. Feedback was used to make informed adjustments and resolve issues more efficiently.

The shift to an alliance model where "either everybody wins, or everybody loses" was due to enhanced *collaboration* (A2). The alliance model fostered partnerships, and the participants worked towards a shared goal to support the national healthcare system. The sense of shared responsibility allowed more determined service development and resulted in putting earlier disagreements aside. *Open and direct communication* (A3) was a strong enabler for collaboration and rapid adaptation to change. It created trust among the partners. The creation of shared feedback mechanisms and communication infrastructure supported this shift, allowing participants to respond to evolving demands on a united front.

To meet these demands, the ecosystem needed *reconfigurable and scalable processes and structures* (A4). Regularly re-evaluating and adjusting processes

ensured flexibility and interoperability across the ecosystem. *Continuous improvement* (A5) was fostered through incremental changes, supported by top-down leadership to align vendors' development efforts. Additionally, the project leveraged the ecosystem's partnerships to foster *innovation* (A6), accelerating problem-solving and creativity in service delivery. According to the findings, this required a clear shared vision, good communication, and a sense of partnership.

Finally, *responsive leadership* (A7) and *empowered teams* (A8) played crucial roles in driving the transformation. Leadership set a clear vision, aligned participant incentives, and ensured changes were implemented across the ecosystem. A culture of collaboration and shared responsibility was fostered, with transformation occurring both top-down and bottom-up. Leaders provided guidance, while teams took ownership of processes and were empowered to make operational decisions, particularly in response to immediate challenges. This reduced delays and increased proactivity in the ecosystem.

Stability factors. Despite the focus on agility, stability was crucial for maintaining consistent service delivery. *Integrated and interoperable systems* (S1) were essential to overcoming the fragmented structures that initially caused inefficiencies and poor communication in the ecosystem. Seamless system integration became a priority, as the Omaolo service needed to be quickly scaled across different regions in Finland.

Although the immediate priority was to respond to the pandemic, some *long-term public service delivery* (S4) elements were considered. The project, for example, ensured that the service was equitably distributed across Finland to support nationwide healthcare access. *Resiliency of the system* (S5) enabled the service to function under increased demand, supported by the participant's ability to respond to changes and integrate new ideas through collaborative efforts.

Although the crisis pushed for rapid deployment and streamlining procedures, *regulatory compliance* (S6) was still addressed to some extent, particularly in terms of compliance with the Medical Device Regulation. This ensured that public safety and service quality were maintained, even under pressure. Some organizations had strong regulatory know-how and predefined processes for managing regulatory compliance, while less experienced ones struggled.

3.3 Article II: Enterprise Architecture as an Enabler for a Government Business Ecosystem: Experiences from Finland

The second paper, "*Enterprise Architecture as an Enabler for a Government Business Ecosystem: Experiences from Finland*" by Ghezzi, Kolehmainen, Setälä, and Mikkonen (2024), examines how Enterprise Architecture can foster a cohesive and efficient government business ecosystem by ensuring system interoperability and integrability within the Finnish public sector. It highlights the need for collaboration between procurement units and vendors to create an Enterprise Architecture that supports a robust ecosystem and effective public service delivery. The

research is published and presented in *Management of Digital EcoSystems: 15th International Conference, MEDES 2023*.

3.3.1 Contribution to the Second Article

As the second author of the article Ghezzi et al. (2024), I contributed to several aspects of the research and writing process. I was responsible for integrating the Ecosystem Governance Compass tool into our data analysis, which helped us examine ecosystem governance and architecture topics within the collected data. My work included identifying gaps between current public ICT procurement practices and best practices from the ecosystem literature in collaboration with the first author. To support this analysis, I developed a lightweight framework of ecosystem characteristics, which we used to compare current practices and generate insights for improvement. This research was essential in refining our research questions and findings.

In the background research phase, I focused on ecosystem design and governance, particularly within governance, business, and regulatory contexts. I also studied Finnish ICT procurement practices and regulations, which informed our understanding of how to map out the ecosystem effectively. I also participated in mapping the ecosystem components, which enabled a systematic visualization of ecosystem components, relationships, and interconnections, offering a view of the current challenges.

During the manuscript preparation, I concentrated on writing sections related to the ecosystem background and findings, drawing on my expertise in these areas. I worked closely with the first author to revise the manuscript, incorporating feedback received from earlier reviewers and ensuring that our arguments were well-supported by the literature.

In terms of review and feedback, I participated in regular meetings with the first author, discussing the findings in relation to ecosystem literature. The manuscript had initially faced challenges regarding its contribution to existing literature, but by incorporating the ecosystem perspective, we were able to add the necessary depth, leading to the article's acceptance. In the final proofreading stage, I focused on ensuring clarity and technical accuracy, especially regarding ecosystem details. I also co-presented the findings at a conference, where I focused on research problem identification and ecosystem-related insights and, finally, answered audience questions about ecosystem formation and governance.

3.3.2 Research Design in the Second Article

The second article by Ghezzi et al. (2024) is also a use case study exploring the state of Enterprise Architecture practices in the Finnish public sector and its possibilities for forming an ecosystemic stance in the public ICT procurement. Data was collected through twelve semi-structured interviews conducted between November 2021 and May 2022. The participants included representatives from five public procurement units and four vendors, all of whom had direct experience with Enterprise Architecture development and public procurement

practices. The selection targeted key participants, including procurement leaders, IT managers, and senior representatives from vendors.

The interview data was then analyzed in two phases: An initial inductive analysis to identify key themes, such as procurement objectives, processes, responsibilities, and control. The more focused analysis using the Ecosystem Governance Compass enabled us to map out ecosystem components, such as Actors, Roles, Incentives, Responsibilities, Business Activities, Costs, and so on. The data analysis revealed significant insights into the inhibitors and enablers of ecosystem formation within the public sector, highlighting the role of Enterprise Architecture in facilitating or hindering the integration of ICT systems across different public organizations. The use of the Ecosystem Governance Compass was particularly effective in visualizing governance structures and identifying critical points of interaction and dependency within the ecosystem. Figure 7 introduces the research process and the 10 themes in more detail.

Figure 7 The analyzing process and forming themes, article II

The key findings from the article demonstrate the critical role of Enterprise Architecture in enhancing public sector efficiency by ensuring system interoperability and promoting collaborative practices in the public sector. According to the

paper, mature Enterprise Architecture both helps in maintaining stability within software ecosystems and enables better agility and flexibility. This facilitates overcoming the rigidity of siloed procurement processes, leading to the development of more dynamic and adaptive ecosystems.

3.3.3 Research Problem

The article emphasizes how siloed, application-specific architectures hinder data interoperability and system integration, leading to repetitive data management, inefficiencies, and rigidities in public service delivery. These inefficiencies arise from the inability of different systems to communicate, leading to duplicated efforts and a lack of coordinated service provision. Moreover, no clear incentives or crossing points exist for fostering cooperation and forming ecosystems.

The study explores how Enterprise Architecture can address these challenges by promoting system interoperability and improving collaborative practices among public and private entities. Despite mandatory Enterprise Architecture guidelines in Finland, adoption rates remain low, with the focus primarily on technology rather than on processes and collaboration.

The research investigates the current state of Enterprise Architecture in public procurement and its potential to support the development of a government business ecosystem. Based on stakeholder interviews, the study identifies how Enterprise Architecture can enhance integration, collaboration, and efficiency in public services through stakeholder interviews. The implications are presented as inhibitors and facilitators for forming government business ecosystems supported by Enterprise Architecture.

3.3.4 Findings in the Second Article

Ghezzi et al. (2024) present how public procurement units enhance their service delivery through an interconnected ecosystem. The findings emphasize the importance of leadership, shared goals, and dynamic governance in achieving successful Enterprise Architecture implementation. Public organizations must adapt their way of working and managing systems to benefit from the ecosystems. The findings are presented here in the context of stability and agility factors.

Stability factors. Mature Enterprise Architecture *integrates disparate systems and supports them to work together seamlessly* (S1) by promoting a unified approach to system development and integration. Standardizing technology improved interoperability in some organizations and minimized data and software duplicity. To establish coherent Enterprise Architecture practices, the study highlights the need for *sufficient control* (S2) and suggests a top-down approach may be necessary to move from fragmented, ad-hoc systems to more controlled Enterprise Architecture practices across different levels. Governance structures help maintain core stability, for example, by aligning resources and ensuring system compatibility with the existing Enterprise Architecture before making purchases.

Standardized processes *minimize risks associated with changes* (S3), such as vendor lock-in, data-management challenges, and legal issues in public

organizations. The study argues that *regulatory compliance* (S6) can be achieved by aligning processes with legal requirements, which reduces the complexity of maintaining compliance across multiple systems. Another recurring theme among interviewees was the need for well-educated benefit evaluations and a shift towards non-monetary metrics when awarding tenders. This affects both risk prevention (S3) and *long-term public service delivery* (S4), where thorough requirement analysis helps avoid misaligned purchases, increased number of vendors, and wasteful spending. According to the study, ecosystems support interoperability and reliability, ensuring that public services are delivered consistently over time.

The final stability factor emphasizes the importance of *clarity and consistency in documentation* (S7). Structured documentation practices, guided by Enterprise Architecture, ensure all system changes and integrations are well-documented and accessible to everyone in the ecosystem. According to the study, clear and consistent documentation supports both stability and the effective implementation of changes in procurement and ICT systems.

Agility factors. The study highlights that public organizations often default to rigid, waterfall-like approaches in service delivery, even when *adaptive management* (A1) would be more effective. Resource allocation and expertise-sharing are essential for both internal and external cooperation. Enterprise Architecture principles can help align incentives for *collaboration* (A2), but this requires upper-level guidance on communication, particularly between vendors and public organizations, who often have differing motivations.

Reconfigurable and scalable processes and structures (A4) ensure that the organizations remain effective even when being challenged with changes. The interviewed organizations had experienced a lack of information sharing and fragmented comprehension of the IT landscape in the organization, hindering flexibility. Forming collaborative ecosystem structures could support individual organizations. The study also emphasizes the need for *continuous improvement* (A5) facilitated by top-down support for iterative development. Ecosystems enhance co-creation and *innovation* (A6), and some interviewees reported success through co-development projects with universities on disruptive technologies.

Finally, the findings demonstrate that *responsive leadership* (A7) is critical to driving Enterprise Architecture adoption. Without strong leadership, the interviewed organizations struggled to create a unified strategy that enables seamless coordination and collaboration across procurement units. This results in inefficiencies and fragmented decision-making processes.

4 DISCUSSION

In the following sections, I will answer each of the research questions based on the two primary articles and literature. Next, I will present key implications for research and practitioners and, finally, reflect on study limitations.

4.1 Answers to Each of the Research Questions

This thesis observes that public organizations face conflicting demands: adapting to changing needs while ensuring public services remain reliable. These themes emerged in two studies on public service delivery in Finland's public software ecosystems. Although neither study directly addressed this specific perspective, both offered valuable insights into the central research question: "*How do software ecosystems improve public service delivery in the public sector while balancing the need for stability and agility?*" To answer this, I considered two distinct requirements for public software ecosystems, leading to two supporting questions for the thesis.

- *How do public sector organizations maintain stability within public service delivery in public software ecosystems?*
- *How do public sector organizations incorporate agility and flexibility into public service delivery in software ecosystems?*

In analyzing the primary articles, I first examined stability and agility factors in public service delivery within public software ecosystems. Then, I compared findings to explore approaches for balancing stability and agility. The first article, "*Unifying a Public Software Ecosystem: How Omaolo Responded to the COVID-19 Challenge,*" by Kolehmainen et al. (2024), focuses on the rapid adaptation of Finland's Omaolo e-health service during the COVID-19 pandemic, highlighting the shift from rigid to flexible, collaborative models for resilient service delivery. In contrast, the second article, "*Enterprise Architecture as an Enabler for a Government Business Ecosystem,*" by Ghezzi et al. (2024), emphasizes the role of Enterprise Architecture in fostering interconnected government ecosystems that balance

service delivery and stability. While Kolehmainen et al. provide lessons on implementing agility during crises, Ghezzi et al. offer structured recommendations for maintaining long-term stability and system adaptability through Enterprise Architecture. This approach supports sustainable service delivery by ensuring system interoperability and integrating public-private collaboration.

The primary articles provided seven stability factors (S1—S7) and eight agility factors (A1—A8) (see Figure 5). Some factors were directly addressed in the analyzed use cases, while others required further exploration. For instance, Kolehmainen et al. emphasized open communication as essential for managing alliances, whereas Ghezzi et al. focused on inefficiencies caused by poor information sharing across government and public-private entities. The final step involved reviewing the specific requirements for both agility and stability and developing approaches to balance these factors, ensuring adaptability while maintaining long-term integrity in public service delivery.

4.1.1 Maintaining Stability in Public Software Ecosystems

The key factors (S1—S7) for maintaining stability in public software ecosystems include integrated systems, sufficient control, risk prevention, long-term public service delivery, system resiliency, regulatory compliance, and clear documentation. The articles differ significantly in addressing stability. Kolehmainen et al. focus on immediate crisis outcomes, which led to deprioritizing multiple stability factors, such as control (S2), risk mitigation (S3), and documentation (S7). In contrast, Ghezzi et al. take a long-term approach, ensuring systems adapt to future needs while maintaining regulatory and operational integrity.

Ghezzi et al. stress integrated systems (S1) as foundational for stability, achieved through Enterprise Architecture, which ensures system alignment and regulatory compliance for cohesive public service delivery. Kolehmainen et al. touch on integration from a more immediate perspective, describing how the system was quickly reconfigured to meet healthcare needs during a crisis. While this reflects short-term integration, Ghezzi et al. argue for a sustainable, long-term approach aligning architecture and compliance to enable different public services to function cohesively. This supports Coskun-Setirek et al. (2023) in aligning architecture with governance to effectively manage the complexities of public service ecosystems.

Management and leadership are central throughout the articles, reflecting their importance in both ensuring stability and agility in public service delivery. In the stability factors, sufficient control (S2) represents the manager's role in coordinating, guiding, and monitoring activities. Ghezzi et al. emphasize how Enterprise Architecture provides governance structures to maintain stability during system integration and public service delivery, supporting well-defined processes for managing system complexity and public-private collaboration. This aligns with Smolander et al. (2021), who stress the importance of structured collaboration to foster innovation without compromising existing services. Managing risks associated with rapid change (S3) ensures stability during disruptions. Although Kolehmainen et al. do not directly address risk management, exploring

how regulatory flexibility was handled during the crisis could have provided valuable insights to the paper. As Teece et al. (2007) suggest in their research on dynamic capabilities, early identification of changes and risks strengthens system resiliency, enabling public software ecosystems to adapt to both minor shifts and major shocks. While dynamic capabilities are often associated with promoting agility, this insight demonstrates that they can also be effectively applied to stability requirements, ensuring that organizations remain adaptable while maintaining long-term stability.

System resiliency (S5) and long-term public service delivery (S4) are interconnected in ensuring stability within public software ecosystems. Sustainability requires resilient systems capable of handling both immediate crises, as seen in the Omaolo case, and gradual transformations, as demonstrated by Ghezzi et al. They emphasize how Enterprise Architecture enables structured and scalable service delivery for long-term stability, while the Omaolo case shows the need for resilient systems to manage crisis situations effectively. Both articles emphasize regulatory compliance (S6) for stabilizing operations and ensuring legal and security standards. Ghezzi et al. focus on how compliance frameworks support sustainability by anticipating and mitigating risks during disruptions, acting as a buffer against external shocks. Lastly, clarity and consistency in documentation (S7), a theme emphasized by Ghezzi et al., ensure that knowledge is preserved for effective system management and adaptation over time.

4.1.2 Incorporating Agility and Flexibility into Software Ecosystems

According to my findings, public sector organizations can incorporate agility and flexibility into software ecosystems by focusing on several key factors: adaptive management, collaboration, direct and open communication, reconfigurable and scalable processes, continuous improvement, innovation, responsive leadership, and empowered teams (A1—A8). Implementing agility in public software ecosystems involves enhancing, adapting, and scaling agile approaches in public service delivery. Kolehmainen et al. highlight the need for quick, iterative processes, while Ghezzi et al. stress that ad-hoc changes are ineffective, requiring structured processes. Both agree that oversight is essential for agility. Adaptive management (A1) enables decision-making adjustments, as seen in Omaolo's shift from rigid governance to flexible structures. While this change appeared reactive due to external pressures, it highlights the importance of adaptable frameworks even in unforeseen situations. In line with earlier findings by Niemi and Pekkola (2020), Ghezzi et al. argue that top-down guidelines are essential for overcoming traditional hierarchies and risk aversion when fostering long-term agility in public service delivery.

Collaboration (A2) is another enabler for agility, although addressed from different perspectives in the articles. In the Omaolo case, close public-private partnerships, driven by shared objectives and a sense of unity, enabled rapid service deployment. Ghezzi et al., however, emphasize the need for integrated approaches to address siloed structures and poor communication, especially in circumstances when motivation for collaboration is lower. Open communication

(A3) was key to fostering trust and transparency in the Omaolo case. While communication and collaboration were central to Omaolo's success, Ghezzi et al. discover that poor transparency hinders compliance and damages trust between public and private entities, echoing earlier research on tensions between private and public entities (e.g., Ghezzi & Mikkonen, 2024; Koski, 2019). Further, Ghezzi et al. view challenges with information sharing more as structural and managerial issues within public procurement rather than a social one. This difference in perspective might reflect Omaolo's focus on a specific use case with defined participants, while Ghezzi et al. aim to offer long-term, standardizable solutions for public service delivery.

Both articles discuss forms of change, emphasizing the role of continuous improvement (incremental) and innovation (disruptive) in public software ecosystems. Reconfigurable and scalable processes (A4) allow ecosystems to adapt to shifting demands. In the Omaolo case, processes were rapidly reconfigured to respond to changing needs, reflecting a reactive, emergent change. In contrast, Ghezzi et al. focus on long-term scalability, providing a stable foundation for planned change. Continuous improvement (A5) ensures adaptability through ongoing iterations, while innovation (A6) drives disruptive change, often through collaboration. Omaolo's rapid service development shows how bold innovation can prioritize agility, sometimes at the cost of other tasks like regulatory compliance. Enterprise Architecture, as Ghezzi et al. suggest, provides the structure for integrating new technologies and balancing innovation and compliance.

Finally, responsive leadership (A7) and empowered teams (A8) allowed Omaolo to reconfigure quickly during the crisis. Ghezzi et al. emphasize structured governance, where leadership aligns teams with long-term goals. In both cases, leadership provides the strategic oversight necessary for incremental improvements and disruptive innovations. These findings build on the earlier literature by demonstrating how leadership, clear communication, and empowered teams can overcome barriers to adaptability in public organizations, further supporting the work of, e.g., Kotter (1995) and Teece et al. (2016) on the role of leadership in driving change.

4.1.3 Balancing Stability and Agility in Public Software Ecosystems

The articles present different approaches to balancing stability and agility in public sector software ecosystems. Omaolo's case prioritized agility and quick action during a crisis, while Ghezzi et al. focused on maintaining stability through structured governance. This contrast highlights how, in emergencies, agility may temporarily overshadow stability, whereas in non-crisis situations, the emphasis shifts to long-term sustainability. Balancing these needs is an ongoing, dynamic process. From the analysis of both articles, I identified six key enablers for balancing stability and agility in public software ecosystems (see Table 4).

Table 4 Enablers for balancing stability and agility in public software ecosystems

Enabler for Balance	Related Stability Factor	Related Agility Factor
Leadership and Governance Structure	Integrated and interoperable systems (S1), Sufficient level of control (S2), Long-term public service delivery (S4), System resiliency (S5), Regulatory compliance (S6)	Adaptive management (A1), Reconfigurable and scalable structures and processes (A4), Responsive leadership (A7), Empowered teams (A8)
Communication and Transparency	Regulatory compliance (A6), clarity and consistency in documentation (A7)	Adaptive management (A1), Collaboration (A2), Open and transparent communication (A3)
Collaborative Practice	Integrated and interoperable systems (S1), Preventing risks associated with rapid changes (S3), System resiliency (S5)	Collaboration (A2), Open and transparent communication (A3), Reconfigurable and scalable structures and processes (A4), Innovation (A6), Responsive leadership (A7), Empowered teams (A8)
Flexible Yet Standardized Practices	Integrated and interoperable systems (S1), Preventing risks associated with rapid changes (S3), Long-term public service delivery (S4), System resiliency (S5), Regulatory compliance (S6)	Adaptive management (A1), Reconfigurable and scalable structures and processes (A4), Continuous improvement (A5)
Incremental Improvements with a Long-Term Vision	Long-term public service delivery (S4), Clarity and consistency in documentation (S7)	Continuous improvement (A5), Innovation (A6)
Organizational Culture	Integrated and interoperable systems (S1), Sufficient level of control (S2)	Responsive leadership (A7) Empowered teams (A8)

Both articles emphasize the importance of governance frameworks like Enterprise Architecture and collaboration models in balancing agility and stability in complex public service delivery. Thus, the first enabler for balance is *leadership and governance structures* for directing collaborative efforts and guiding the ecosystem based on the operating environment. In Omaolo's case, leadership was adaptive and reactive (A1, A7), quickly clarifying roles to address the external crisis. Kolehmainen et al. demonstrate how empowered teams (A8) could make decisions rapidly while maintaining system resilience (S5), addressing the need for more empirical studies on change processes in public contexts (Kuipers et al., 2014). In contrast, Ghezzi et al. stress structured governance, where leaders provide long-term direction through strategic oversight (S2) and guidance for long-term service delivery (S4), ensuring system interoperability and sustainability (S1). Mature governance structures, like Enterprise Architecture, allow organizations to reconfigure their processes (A4) while maintaining regulatory alignment (S6), echoing Niemi and Pekkola (2020) on Enterprise Architecture's role in balancing both flexibility and control. Nurmi et al. (2019) further suggest expanding

Ecosystem Architecture to manage public-private collaboration, a claim supported by Ghezzi et al.'s findings on its role in enhancing public ecosystems.

Both articles stress that *clear communication and transparency* are essential for rapid decision-making, trust-building, and aligning public-private objectives, supporting Holma (2020) on collaboration. Kolehmainen et al. demonstrate that open and direct communication (A3) promotes agility by fostering collaboration (A2) and enabling direct channels for quick decision-making and adaptability (A1). Ghezzi et al. point out that rigid processes and resource limitations in Finnish ICT procurement often hinder effective communication, as discussed from various perspectives also by Ghezzi and Mikkonen (2024), Koski (2019) and Nuottila (2016). Additionally, Ghezzi et al. underline that communication supports stability by ensuring regulatory compliance (S6) but requires consistent information sharing, for example, through proper documentation (S7).

Communication (A3) is fundamental for fostering *collaborative practices* within ecosystems. Omaolo's alliance model approach highlights how immediate, crisis-driven collaboration (A2) around the shared goal of national safety helped build a resilient system (S5). The pandemic urgency strengthened partnerships, showing how aligned incentives facilitated problem-solving and new opportunities (A6), confirming findings by Cardoso et al. (2013). In contrast, Ghezzi et al. focus on long-term collaboration frameworks, where system integration (S1) and risk mitigation (S3) were the goals. Omaolo's shift from hierarchical, contract-based models to a more flexible alliance reflects changes in collaboration models, noted by Smolander et al. (2021). However, as the focus shifts back to long-term objectives and continuous planning (A4), collaboration models must evolve again. While literature supports the benefits of agile collaboration (for example, Mathiassen & Pries-Heje, 2006; Tallon et al., 2019), Ghezzi et al. note that Finnish public organizations often struggle with rigid, top-down structures, which hinder collaboration (A2) and the development of shared vision (A7).

Flexible yet standardized practices enable adaptation while maintaining system resiliency (S5), as shown by Omaolo's rapid updates. Kolehmainen et al. offer a practical example of how public ecosystems can adopt agile practices with flexible governance structures (A1) and continuous improvement (A5), driven by leadership and a cultural shift toward collaboration. This contrasts with literature on the difficulty of introducing agility in traditionally hierarchical public sector projects (Holma et al., 2020; Nuottila et al., 2016; Pekkola et al., 2022). Omaolo's success demonstrates that public organizations can implement agile strategies when driven by urgent needs and a shared vision. Ghezzi et al. add that long-term public service delivery (S4) and regulatory compliance (S6) depend on well-structured and interoperable systems (S1), along with strong management (A1) and reconfigurable processes (A4). This balance enables ecosystems to evolve while maintaining stability and mitigating risks from rapid changes (S3).

The articles offer differing perspectives on change while both stressing that aligning *incremental improvements with a long-term vision* supports continuous improvement (A5) and ensures long-term service delivery (S4). Omaolo's response contributes to an empirical understanding of emergent change in the public

sector, as called for by Kuipers et al. (2014). The urgency and partnerships helped overcome typical barriers like hierarchical resistance and misaligned objectives (Ghezzi & Mikkonen, 2024; Kuipers et al., 2014). In contrast, Ghezzi et al. propose using Enterprise Architecture to address these barriers, enabling structured and well-documented (S7) change while fostering adaptation and innovation (A6), aligning with Kuipers et al. (2014)'s planned change strategies.

Both cases highlight that an *organizational culture* embracing change and ensuring accountability is essential for managing the tension between agility and stability in public software ecosystems. A supportive culture integrates systems (S1) and provides strategic oversight (S2), while fostering agility through responsive leadership (A7) and empowering teams (A8) to adapt and innovate. In the Omaolo case, top-down support for change enabled quick adaptation during the crisis, aligning with Kotter (1995) and Kuipers et al. (2014) on the role of leadership in driving the culture change. Ghezzi et al. emphasize a culture of responsibility maintained through top-down change management, echoing Teece et al. (2007) on the importance of strong leadership in balancing these efforts.

In conclusion, the findings expand on the literature by integrating agility and stability in public service delivery. While many studies focus on one dimension, this thesis shows how frameworks, such as Enterprise Architecture and the alliance governance model, can act as both a stabilizer and an enabler of agility in complex ecosystems. Balancing these forces is a continuous and dynamic process, and following Teece et al. (2016), organizations must be able to shift between transformation and stability, as ongoing change is unsustainable and inefficient. Likewise, stability without change can lead to stagnation, leaving public ecosystems vulnerable to external disruptions and unable to adapt to evolving demands.

4.2 Implications for Research and Practitioners

This thesis provides an analysis of how public software ecosystems balance the demands of agility and stability, with a focus on governance structures like Enterprise Architecture and collaborative governance models. Both the Omaolo case and the case by Ghezzi et al. demonstrate that, with the right structures, public organizations can remain flexible and responsive during crises while maintaining long-term system integrity. These findings are relevant for policymakers and public organizations improving service delivery, offering practical insights for managing collaborative efforts in software ecosystems.

The research advances both theoretical and practical understanding of public software ecosystems, particularly in balancing agility and stability in complex ecosystem settings. This study contributes to existing knowledge by highlighting the roles of leadership, governance structures, and collaboration in achieving this balance. A notable new insight from the study is the role of Enterprise Architecture as more than just a tool for system stability and regulatory compliance. When implemented effectively, the findings show that Enterprise Architecture can also enhance agility by ensuring flexible system reconfiguration, which is

essential in adapting to new public service demands. This contrasts with the traditional view of Enterprise Architecture as primarily a stability mechanism, opening new avenues for empirical research on how Enterprise Architecture can foster both flexibility and long-term service sustainability.

The emphasis on crisis-driven adaptation in public ecosystems shows that public organizations can adopt agility more effectively than traditionally thought. The Omaolo case reveals how ecosystems can rapidly adapt to external shocks while maintaining critical stability factors. This challenges the conventional view of public organizations as slow and rigid, raising questions about how these temporary adaptations can be institutionalized into long-term governance models post-crisis. Future research should explore how agile measures can be integrated into sustainable frameworks without compromising compliance and resilience.

A key takeaway for the public sector is the need to balance agility and stability within software ecosystems to meet legal obligations while collaborating with the private sector. Leaders must ensure systems are both resilient for long-term sustainability and agile enough to handle immediate challenges. Standardized yet flexible processes help manage these complexities. Close collaboration between public partners is essential, particularly in breaking down silos and ensuring transparent communication. Adaptive governance, combined with empowered teams, enhances decision-making while maintaining long-term oversight. Private sector partners can support agility, while the public sector ensures compliance and system stability.

4.3 Opportunities for Further Research

The results showed the critical role of effective public-private collaboration in driving agile responses, especially during crises. This raises the need for further investigation into how different collaboration models influence both agility and stability over time. This study presented two distinct environments for collaboration but lacked the opportunity to examine their dynamic evolution. The study underscores the role of leadership and organizational culture in balancing the tensions of agility and stability, calling for a deeper exploration of leadership styles and cultural shifts that best facilitate continuous improvement and innovation in public organizations. These research areas could contribute to optimizing public sector service delivery in complex and dynamic environments.

Additionally, the findings highlight a variety of challenges when balancing agility and stability, suggesting future research explore frameworks that integrate both. While Enterprise Architecture was shown to be vital for system interoperability and regulatory compliance, more research is needed to explore its potential to promote agility – especially when applying to more complex ecosystemic environments. Empirical studies could deepen insights into the potential of Enterprise Architecture to enhance agility in public ecosystems. The crisis-driven adaptation in Omaolo opens interesting avenues for understanding the limits within which stability measures can allow room for agile approaches

without compromising, for example, safety in service. Continuing from there, these results suggest further research into how emergency-induced changes can be incorporated into stable governance models post-crisis. Investigating how ecosystems maintain long-term sustainability while responding flexibly to change would advance this understanding.

Finally, this research paves the way for future studies and investigates additional strategies for governing ecosystems in diverse public sector settings. Research could assess the scalability and adaptability of these frameworks in different contexts, taking into account the influence of evolving regulatory pressures and technological advancements on both agility and stability.

4.4 Study Validation and Limitations

Validation of the findings was achieved through a comparative analysis of two distinct case studies, providing diverse perspectives on public software ecosystems. By examining both the crisis-driven adaptation in Omaolo and the structured, long-term approach of Enterprise Architecture, I could ensure a balanced exploration of agility and stability. Cross-referencing the findings with literature further reinforced their reliability, highlighting consistencies and gaps that align with broader research. However, future empirical studies are needed to confirm these findings across different public service contexts and over time.

This study has limitations, and acknowledging them provides a balanced interpretation of the findings. The major limitation lies in the focus on two primary articles, which may not fully represent the diverse operational environments of public software ecosystems in other regions or sectors. While the analysis of the Omaolo ecosystem collaboration model and examining the potential of Enterprise Architecture in government ecosystems provide valuable insights for the research question in this thesis, the findings may be context-dependent and challenging to generalize. Additionally, the rapid adaptation required during a crisis may have influenced the Omaolo outcomes, making it difficult to generalize the results to non-crisis environments. Thus, future research should explore further how the findings apply in more stable contexts and examine the long-term sustainability of balancing strategies in public software ecosystems. While the study by Ghezzi et al. offered a partial balancing solution to this challenge, the role of Enterprise Architecture in this thesis needs to be critically examined. Usually, enterprise architecture is seen as a tool within an organization, whereas in the article under review, it was applied to a much broader context.

Additionally, the study scope was limited to the findings in the primary articles, which, while providing a strong foundation for analysis, limits the depth of empirical data on the topic. More comprehensive field studies or a broader dataset could strengthen understanding how public software ecosystems balance agility and stability in various settings. Despite these limitations, the research offers important contributions by highlighting key factors that affect the balance between agility and stability, laying the groundwork for further study.

5 CONCLUSION

Public sector organizations face increasing pressure to be both adaptive and resilient, particularly during crises. Traditional, hierarchical models of service delivery and procurement are often too rigid to meet evolving demands, requiring a shift in mindset and operations within software ecosystems. In this thesis, I examined how software ecosystems, integrating public and private partners, enhance public service delivery by balancing stability and agility. The research is grounded in two co-authored articles that examine these dynamics in depth. The first article, "*Unifying a Public Software Ecosystem: How Omaolo Responded to the COVID-19 Challenge*" by Kolehmainen et al. (2024), examines the rapid shift to an agile "alliance model" during the COVID-19 pandemic, enabling quick, adaptable healthcare service delivery. The second article, "*Enterprise Architecture as an Enabler for a Government Business Ecosystem*" by Ghezzi et al. (2024), explores how Enterprise Architecture ensures system interoperability in the public sector, emphasizing collaboration between procurement units and vendors to enhance public service delivery.

Software ecosystems enhance efficiency, effectiveness, and responsiveness in public services by enabling resource pooling, connecting with business innovations, and maximizing impact while promoting long-term adaptability. However, ecosystems are complex and interdependent environments that challenge traditional service delivery and collaboration approaches. Balancing stability and agility is essential to ensure that public services remain reliable while adapting to changing needs in public software ecosystems. First, the two distinct use cases provided seven stability factors and eight agility factors. Maintaining stability in public software ecosystems relies on key factors such as integrated systems, sufficient control, risk prevention, long-term public service delivery, system resiliency, regulatory compliance, and clear documentation. The articles approached these factors differently. Kolehmainen et al. (2024) prioritize immediate crisis outcomes, which led to deprioritizing stability factors like control, risk mitigation, and documentation, while Ghezzi et al. (2024) focus on long-term adaptability, ensuring that systems can meet future needs while maintaining regulatory and operational integrity. On the other hand, incorporating agility and flexibility into

these ecosystems is achieved through factors like adaptive management, collaboration, open communication, reconfigurable and scalable processes, continuous improvement, innovation, responsive leadership, and empowered teams. Agility in public software ecosystems involves continuously enhancing and adapting processes to meet evolving public service delivery demands.

The main research question was, *"How do software ecosystems improve public service delivery in the public sector while balancing the need for stability and agility?"* Altogether, I identified six interrelated enablers for balancing stability and agility in the public software ecosystems, with leadership and governance at the core. Key enablers such as leadership and governance structures ensure that public services remain adaptable while maintaining long-term stability. Communication and transparency facilitate effective collaboration and quick decision-making, which is essential for responding to immediate needs without compromising regulatory compliance. Collaborative practices promote shared problem-solving and innovation, while flexible yet standardized practices allow systems to adapt to changes while preserving core stability. Incremental improvements with a long-term vision ensure continuous enhancement of services while maintaining a focus on long-term sustainability. Finally, a supportive organizational culture fosters responsiveness and stability, enabling public sector organizations to meet the demands of service delivery while ensuring reliable, consistent outcomes.

An unexpected finding was the Omaolo ecosystem's ability to implement agile strategies more effectively than anticipated. Omaolo's swift adaptation to the challenges of COVID-19 contradicts the assumption that public organizations struggle with rapid change due to bureaucratic constraints. The result suggests that public organizations can adopt agile practices more effectively than expected under the right conditions—such as strong leadership, clear communication, and a shared vision. This raises the potential for further research into whether crisis-induced flexibility can be sustained in non-crisis situations. Another key finding is that Enterprise Architecture, traditionally seen as a stabilizing force, can also enhance agility when well implemented. It does not only support integration and regulatory compliance but also enables system adaptability through reconfigurations. This shows that Enterprise Architecture can promote both agility and stability, making it a more versatile tool than previously thought.

This research helps public organizations design and implement more effective software ecosystems that balance stability and agility, improving public service delivery. Further, it provides insights that inform policymakers on how to support public-private collaboration for developing robust ecosystems. This research opens avenues for future research to build on the findings to explore additional strategies for governing ecosystems in different public sector contexts. Additionally, it highlights the need to evaluate how public processes, such as procurement, could be better aligned to support ecosystem development, fostering more agile and resilient service delivery. As ecosystem formation gains importance in procurement practices in Finland, this study contributes to the broader understanding of how software ecosystems impact public service delivery and the challenge of balancing stability with agility in complex and dynamic ecosystem settings.

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Unifying a Public Software Ecosystem: How Omaolo Responded to the COVID-19 Challenge

This is the preprint version of the manuscript, awaiting formal peer review and publication.

September 27, 2024

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Title: Unifying a Public Software Ecosystem: How Omaolo Responded to the COVID-19 Challenge

Abstract: Public actors are often seen as slow, especially in renewing information systems, due to complex tendering and competition regulations, which delay decisions. This challenge is even greater in multi-company ecosystems. However, when faced with a common threat, the ecosystem needs to unite to face the challenge.

This study explores how the Omaolo ecosystem in Finland evolved from traditional public-private cooperation to an alliance model during the COVID-19 pandemic from 2020 to 2022. It highlights how the crisis accelerated changes in operations and collaboration between public and private participants, identifying key shifts, benefits, and challenges.

Key findings include the removal of traditional barriers and the creation of an alliance approach that sped up the development of Omaolo's symptom assessment tool. This improved collaboration, service scalability, and responsiveness to healthcare needs despite the initial regulatory and stakeholder alignment challenges.

The study concludes that crises can drive agile responses in public ecosystems. The new collaboration model helped Omaolo to adapt quickly to changing service demands, managing healthcare patient loads more effectively. These findings highlight the value of flexible, collaborative strategies for responding to emergencies in public software ecosystems.

Keywords: Public Software Ecosystem, Strategic Alliances, Crisis Response, Public Sector Innovation

1 Introduction

Digital platforms, such as the smart grid, various digital services for healthcare, banking, or shopping, cloud platforms, and Internet of Things platforms, are intertwined in the business and citizens' everyday lives. The success of businesses and public sector organizations depends on their ability to exploit new technologies and the social capacities afforded by the platforms.

Platforms are often developed by a network of organizations, each contributing with their own services and components. Together, these components aggregate the platform. When the platform is established, the organizations agree on the means and methods, for instance, how the platform should be constituted, what services are included, and, importantly, how the development activities will occur. Public platforms designed and developed for digital public services are constrained and driven by rules, regulations, and explicit agreements.

This is an adequate approach in a relatively static situation.

The global COVID-19 pandemic changed the game. It thrust the capabilities and resilience of healthcare systems, public services, and digital platforms into the spotlight. Previous agreement-based approaches with numerous, time-consuming quality controls and rigid agreements defining goals, methods, and schedules became inappropriate overnight when people's lives were put on a plate.

This article tells the story of the evolution of the software ecosystem of *Omaolo*, an e-health service where Finnish citizens could, among other contents, check whether their symptoms were severe and would require medical assistance or hospitalization. The service development began in 2016 when the Finnish government granted funding to fourteen municipalities or joint municipal authorities, a medical content provider, and two IT companies to implement some basic features of the healthcare platform. The development proceeded slowly, each partner constantly securing their own backs, ensuring correct diagnoses, and producing high-quality services. An external shock, COVID-19, changed the situation, and the common threat significantly sped up development. The old approach to platform development with strict rules, practices, and divisions of labor was replaced by *an alliance model* where

either everybody wins – or everybody loses. The alliance model refers to the flexibility and adaptability of the ecosystem and its common goals, shared visions, and risks. Importantly, the model rewards the participants for achieving the objectives with bonuses or penalizes them for exceeding the budget or schedule or failing the features.

External incidents or shocks, such as COVID-19 or other changes in the organization's operational environment, and internal incidents, such as acquisitions and mergers or organizational changes, are not uncommon. Under the circumstances, the organizations need to react to them somehow. For example, Smolander et al. (Smolander, Rossi, and Pekkola 2021) identified four modes of collaboration in large enterprise systems development, each prevailing under different conditions and shifting to another when an incident occurs. These changes, however, necessitate organizational ability and agility.

As a technical contribution, the article studies how the relationship between the organizations developing the Omaolo service evolved from a network-based approach to an approach resembling an alliance during the early months of the COVID-19 pandemic. Our overarching goal is to extract valuable insights that can inform future preparedness and resilience strategies, extending beyond technical considerations to encompass the actors' roles, incentives, regulations, business, and software within the ecosystem.

1.1 BACKGROUND

1.1.1 Public Software Procurement

Public sector organizations are bound by procurement policies when acquiring information and communication technology products and services, including software. The primary objective of public procurement guidelines is to enforce transparency, fairness, and cost-effectiveness throughout the procurement process. Guidelines, implied by the policies, typically encompass criteria for vendor selection, contract negotiations, and software management. The adoption of these policies may differ at the national level because there are no universally recognized international standards for software procurement.

In most countries, administration and government functions are divided among multiple

agencies. Typically, each agency procures its own software solutions. This is done by issuing tenders for complete systems, often resulting in monolithic systems with limited interfaces for reuse. Maintenance tasks are typically tied to the selected vendor, who is responsible for maintaining the system throughout its operational life cycle.

An alternative way to develop such software has been proposed by (Ghezzi et al. 2023). The authors argue for improved resilience in public software systems when several vendors can participate in the development. This, in turn, means that a government-led ecosystem is formed to develop and maintain public sector software.

1.1.2 Public Sector Digital Ecosystems and Their Governance

Ecosystem thinking allows public procurement participants to pool resources to optimize the software's reusability and interoperability and enhance service delivery. In practice, this could mean complying with common standards and providing compatible and complementary solutions. It also encourages innovation and agile practices to enhance productivity, reduce costs, provide competitive edge solutions, and enable shared issue-solving.

Each element in the ecosystem influences and is influenced by the others, resulting in a complex network of inter-dependencies (Peltoniemi and Vuori 2004). For instance, changes in one part of the ecosystem, such as introducing new software, can send ripples throughout the ecosystem, demanding adjustments in other elements. Maneuvering in these complex and interdependent settings, organizations need to move towards a more holistic and dynamic mindset instead of focusing on controlling their current resources. Generally, some of the requirements for creating value in ecosystems could be, for example, the following:

- Enhanced integrability and standardization (Sklyar et al. 2019).
- Open and adaptive resource integration (Sklyar et al. 2019).
- Establishing common goals and compatible incentives (Adner 2017).
- Improving agility (Dattée, Alexy, and Autio 2018) and multilateral compatibility (Adner 2017).
- Fostering partnerships and flexibility in ecosystem management (Iansiti and Levien 2004).

- Collaborative value creation, for example, through innovation (Iansiti and Levien 2004). Finally, digitalizing services is essential for creating an ecosystem (Sklyar et al. 2019).

Creating a collaborative and interconnected ecosystem requires organizations to commit to shared objectives and decision-making and to have appropriate structures, rules, and practices. Ecosystem governance refers to the development, management, and control of shared processes, operating models, practices, principles, and rules that enable the formation of such ecosystems (Laatikainen, Li, and Abrahamsson 2021). In the public settings, decision-making and governance tend to be centralized and government-led. However, to maintain agility and enable innovation, some decentralization should be allowed within the agreed limits.

In this study, we follow how a networked governance model, where each participant contributed from their own perspective, evolved into an alliance model approach. The alliance model is a project delivery method used in public procurement in Finland, where the governmental agencies closely partner with private companies (Pekkala et al. 2022). In the model, the alliance acts as a cohesive team, under the terms agreed in the contract, to complete the project so that the jointly set and agreed objectives are met (Jefferies, Brewer, and Gajendran 2014). Often, the alliance model is "no blame, no disputes," meaning that the parties must be able to trust and support each other (Jefferies, Brewer, and Gajendran 2014). In the alliance model, part of the cost risk is in the implementing company, i.e., an alliance is an agreement between two or more parties who take on a project jointly and severally, with shared profit and loss. The incentive scheme ensures that everyone works well together and focuses on making the project successful (Jefferies, Brewer, and Gajendran 2014). The COVID-19 pandemic accelerated the formation of new strategic alliances across different sectors to address the immediate demands of, e.g., core healthcare (Cojoianu, Haney, and Meiring 2020). Here, the role of governments is key in guiding the overall vision for both the immediate and longer-term needs (Cojoianu, Haney, and Meiring 2020).

1.1.3 Omaolo and Its Ecosystem

Omaolo is an electronic service and interaction channel for social and health care that supports self-care and self-help and directs individuals to appropriate assistance. The starting point was the government's objective to increase self-service and automation in the social and healthcare service model in 2016. With Omaolo, citizens can easily assess the type of care needed and receive personalized guidance or, if necessary, send contact requests. The system includes symptom assessment, health check-ups, and comprehensive well-being coaching to promote overall health. Social service assessments help determine eligibility for specific services.

Omaolo is a CE-marked medical device from May 2022 onwards, which complies with the EU Regulation 2017/745 (MDR) requirements (EU). The CE-marking signifies exceptional quality and safety and of their documentation for citizens using Omaolo and health and social care professionals. Consequently, the Omaolo system can provide up-to-date information to improve the effectiveness of social and health services and build different service channels, thus facilitating interaction between citizens and health professionals.

Omaolo involves several stakeholders having different roles, responsibilities and incentives in the ecosystem. These are briefly summarized in Table 1.1.

Actor	**Role**	**Responsibility**	**Incentives**
Finnish Government	Financing Body; Policy Maker	Ensure healthcare services are available to citizens. Provide funding and strategic direction aligned with national healthcare priorities.	Promote enhanced utilization of e-services, encompassing self-care and counseling, to support citizen engagement.

In-House Company	Ecosystem Coordinator and Facilitator	Provide and administrate public sector digital services for Finland, including Omaolo. Oversee project management and coordination between stakeholders and foster collaboration.	Support digitalization of healthcare services. Enhance public sector efficiency.
Medical Content Expert Organization	Content and Knowledge Provider	Provide medical content knowledge base for the service. Continually update medical content for accuracy and relevance.	Contribute to public health knowledge and leverage expertise in digital healthcare solutions.
Companies	Vendors; Technical Solution Providers	Provide a range of IT services to DigiFinland to improve existing offerings and implement new solutions to ensure innovation, agility, and responsiveness to healthcare needs.	Increased sales and increased portfolio via expanded market presence and technological innovation.
Regulatory and Standard-Setting Organizations	Healthcare Regulatory Authorities; Device Certifiers	Protect public safety through regulatory actions, ensuring compliance with healthcare regulations, and certifying medical devices.	Legal obligations. Maintain high standards of healthcare quality and safety in digital solutions.

Regional Operators (municipalities, well-being service counties)	Public Healthcare Service Providers and Organizers	Operationalize services to citizens. Implement and adapt services to local healthcare needs, engaging with communities.	Optimize the allocation of healthcare professional resources for greater efficiency. Improve local health outcomes by delivering services that meet regional demands.
National Health Agencies	Healthcare Strategy, Policy Advisors, and Regulatory Contributors	Guide health policies, advise on strategy, and contribute to regulatory processes. Evaluate the public health impact of Omaolo.	Effective healthcare policies and successful implementation of health strategies.
Healthcare Professionals	Service Users	Participate in service co-development wherever possible and provide clinical feedback for improvement.	Enhance practice efficiency and patient care.
Citizens	Service End-users	Use health care services responsibly by choosing a suitable channel for engaging. Provide feedback for improvement.	Decide when to resort to self-care and when to contact healthcare professionals based on convenience, effectiveness, and responsiveness of the services.

Table 1.1: Key Omaolo ecosystem actors, their roles, responsibilities, and incentives.

1.2 RESEARCH APPROACH

This study examines the Omaolo service as a public software ecosystem. The study is thus a case study of the Omaolo platform and its management during the COVID-19 pandemic from 2020–2022. We examine, particularly, the changes that took place in the administrative roles and responsibilities of the platform as a result of the pandemic-caused crisis.

To understand the ecosystem evolution, we conducted a set of nine semi-structured interviews and gathered publicly available documentation. The interviews were carried out during Fall 2023, by which time the pandemic was considered as no longer an endangering disease in Finland. Table 1.2 lists our informants.

Deriving the interviewees' experiences, we modeled the Omaolo ecosystem using the Ecosystem Governance Compass, a domain-specific modeling language (Sroor et al. 2022) enabling visual modeling of ecosystem components, interactions, and dependencies between ecosystem participants. The Ecosystem Governance Compass maps the building blocks of a digital business ecosystem from governance, business, and technology perspectives. It examines the regulation of cooperation and the obligations of actors in a legal context (following Laatikainen et al. (Laatikainen, Li, and Abrahamsson 2021)). The resulting models support analyzing and exploring a complex ecosystem via knowledge integration (Mader et al. 2008).

We particularly focused on understanding the ecosystem governance structures and model, interactions and inter-dependencies between the actors, responsibility distribution among the roles, and decision-making processes. By modeling relevant components and their causal and dependent interactions, we were able to identify the ecosystem structures and governance mechanisms (Mader, Wupper, and Boon 2007).

ID	Organization	Particant Role	Min	Key Topics
INT01	Vendor	Project Lead, Designer	63	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
INT02	Public Sector	Medical Director	54	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
INT03	Public Sector	Medical Director	54	Governance, COVID-19 response
INT04	Public Sector	Portfolio Manager	82	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
INT05	Vendor	Senior Software Engineer	74	Values, Cooperation, Technology
INT06	Public Sector	Head of Operations	36	Business, COVID-19 response
INT07	Public Sector	Senior Software Engineer	61	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations
INT08	Vendor	Development Manager	49	COVID-19 response
INT09	Vendor	Medical Director	88	Governance, COVID-19 response, Values, Cooperation, Technology, Innovation, Regulations

Table 1.2: Interview subject, their background, recording duration and key topics discussed.

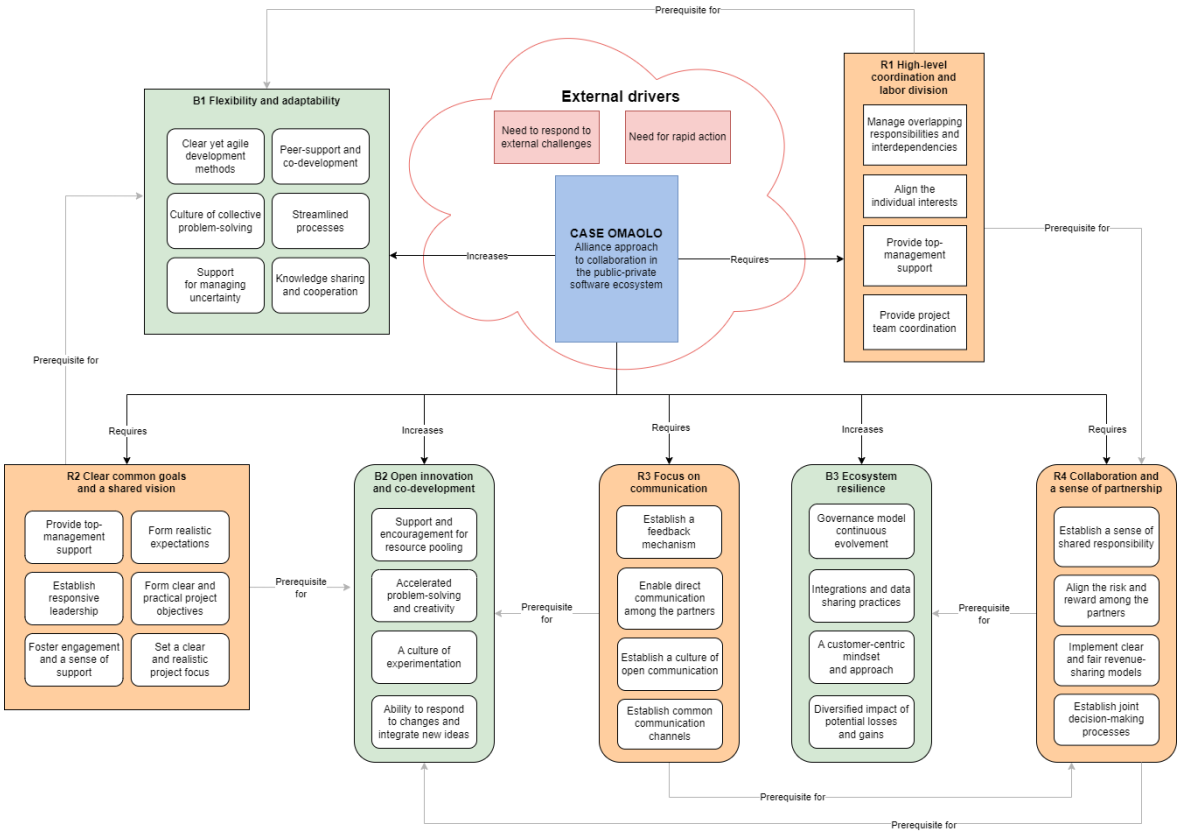

Figure 1.1. Benefits (B) and requirements (R) for alliance approach in the case Omaolo.

1.3 FINDINGS

An external incident or threat, the COVID-19 pandemic, forced the Omaolo ecosystem to evolve from traditional public-private cooperation towards an alliance approach. When the pandemic hit, the development focus was quickly directed toward the Omaolo symptom assessment. The sense of urgency and purpose shaped the ways in which the ecosystem participants addressed the common threat and took action in a rapidly changing situation. They had a common goal of sustaining Finland's healthcare system even when the patient load skyrocketed. The participants removed the boundaries between public and private organizations, started to work very closely together, and aligned their service development efforts. In this paper, we identified three benefits (B1–3, see Figure 1.1) that emerged from the change of focus and collaborating effectively. Also, four strategic requirements (R1–4, see Figure 1.1) must be in place for such an all-win-or-all-lose alliance to play out. These changes were not without challenges, as the ecosystem had to manage evolving situations and regulatory

complexities while developing regulated medical software.

First, flexibility and adaptability (B1) were emphasized when navigating rapidly changing conditions. The urgency of the COVID-19 pandemic resulted in streamlining the processes, particularly in tendering and agreement protocols, and led to evident behavioral changes among the contracting entities and policymakers. For example, direct negotiations replaced the usual tendering and bidding processes, and flexibility was embraced over strict adherence to standard procedures. Public sector entities strategically utilized existing framework contracts with vendors instead of issuing new tenders. Policymakers and healthcare providers displayed adaptability by enabling a more pragmatic approach, deviating from conventional 'by the book' methods to meet the project's urgent demands. To ensure fast software delivery, there was a need to coordinate and align conflicting interests (R1), for example, in meeting the medical device regulation requirements. Developing regulated medical software at a rapid pace favored those companies that had strong regulatory know-how and predefined processes for managing regulatory compliance. Further, shared goals and a vision (R2) between the vendors and the coordinator facilitated the determined deployment of the Omaolo e-health service. The common alignment enabled bold actions and agile adjustments in the service based on user feedback. Finally, efficient data sharing among vendors, healthcare professionals, and government entities ensured that the service was in line with Finland's evolving national COVID-19 strategy. Coordination efforts included, for example, the medical director maintaining the dialogue with various medical actors throughout the project (R1). However, despite facilitating information exchange between the stakeholders, some change requests were received simultaneously with the public. This then required immediate updates to the software.

Second, the need for rapid solution development and deployment promoted open innovation and co-development (B2). The actors sought ways to collaborate and address changing demands. This necessitated immediate and close collaboration, which was perceived as effective and beneficial by all parties. Meetings were kept short and informal, and anyone with relevant knowledge could join at a low threshold (R3). During the most critical times, the actors concentrated entirely on updating the syndrome assessment content, shared the same objectives (R2), and postponed the development of other Omaolo features. Omaolo's highly

automated assessment of symptoms and laboratory test scheduling in the most affected regions significantly influenced the implementation of the national COVID-19 strategy and the effective management of patient loads. Further, this shift in collaboration (R4) facilitated changes in the ways of working, for example, supporting remote work and flexible office hours. The sense of shared responsibility also resulted in ignoring previous disagreements and putting them aside. In the interviews, each vendor reported working long hours, prolonging into evenings and weekends, and demanding commitment from both teams and their families (R4).

Third, the pandemic required quick adjustments, especially in coordination (R1) and communication (R3), to increase ecosystem resilience (B3). The crises brought focus to hierarchical and organizational structure in the ecosystem, highlighting the importance of agile and joint decision-making (R4). Initially, the COVID-19 response lacked clear specifications, and decisions had to be made on the fly to meet the urgent demands set for the Omaolo service. The responsibility of balancing between the quality and speed of deployment was on each individual actor. Later, the collaboration practices became more structured, with clear roles, responsibilities, and schedules for the development. Further, there had been earlier attempts to centralize communication in the Omaolo ecosystem before the pandemic. However, such centralization in communications quickly became ineffective as the ecosystem faced a common threat, resulting in alternative channels and secretive communication for technical issues. This led to a rapid change in communication strategies when faced with the common threat, emphasizing the need for flexibility in crisis management. Communication became more direct and effective (R3), connecting those who understood the issues with those who could resolve them. Another success factor was the readily available and quickly formed deployment pathways and processes for the symptom assessment in two hospital districts, as well as a well-functioning network for information sharing. From the healthcare point of view, the service had concordant practices and care paths. However, while health professionals were only partially familiar with the Omaolo pilot project before the pandemic, introducing new functions was straightforward in the most affected areas due to, e.g., active promotion of Omaolo and prioritizing digital services.

The race against the pandemic caused several challenges. One of the main difficult points

was adjusting Omaolo with the national strategies, which were changing fast and requiring frequent updates. This urgency created high-pressure work conditions with extended working hours, impacting not only the development teams but also their personal environments. Balancing the immediate focus on the COVID-19 response – while simultaneously resuming the broader development of the Omaolo e-health services – demonstrated the challenges of managing a critical healthcare project under quickly changing circumstances. In addition, the COVID-19 project navigated through regulatory complexities with mixed opinions and interpretations and under heavy time pressure. Some found it burdensome and costly, while others appreciated the structure it provided, standardizing and assuring software quality. However, limited resources slowed the Omaolo development process and impacted the software quality, as regular updates were essential. The service was made freely available to all user organizations and centrally financed by the government to ensure equal service throughout Finland when meeting the rapid demands of the COVID-19 emergency. During the pandemic, the short-term profitability of the service was not a concern.

In summary, the Omaolo case illustrates the potential of the alliance model in terms of flexibility and adaptability, ecosystem resilience, and supporting innovation and faster responses in public healthcare software development. Our findings indicate that the emphasis on common goals and shared vision, communication, collaboration, and coordination significantly contributed to the successful development of the Omaolo software.

1.4 DISCUSSION

The COVID-19 pandemic changed society and people's ways of working, as well as how the digital ecosystem operated. With the Omaolo case, an alliance approach to mobilize a public-private partnership transformation and enable the development of COVID-19-specific features to the Omaolo e-health service emerged during the pandemic in the years 2020–2021. Although the structure and management practices of the Omaolo ecosystem have evolved throughout its existence, the pandemic initiated fundamental changes. These changes impacted the progress and stability of the system during the pandemic.

The platform ecosystem's ability to react to the pandemic required organizational resilience

from all parties. Such responsiveness and change are not easy and evident. Abandoning old rules, regulations, work practices, communication means, individual incentives, business interests, and traditions and replacing them with a shared incentive and straightforward get-things-done-quickly attitude and practices did not happen easily. With Omaolo, the pandemic drove the parties, and frankly speaking the whole country, into a situation where the healthcare system collapses if all citizens enter the hospitals en masses to check whether they have severe COVID-19. Under these circumstances, the need for self-service through Omaolo became vital. The pandemic was an external incident, a shock, or a catalyst (compare to Smolander et al. (Smolander, Rossi, and Pekkola 2021)) that put the ecosystem in a position to be a hero and save the country – or fail. This intrinsic motive in the Omaolo ecosystem allowed the parties to cut corners in every possible way.

In addition to external shock and internal motivation, the change also entails adequate cultural, educational, and societal background and context. In the spirit of Christensen and Eyring (Christensen and Eyring 2011), organizations, and their employees cannot respond to changes quickly unless such ability is built in their DNA. Luckily, the ecosystem DNA allowed this. The alliance model postulates open information and transparency in the relationship between public and private partners (Jefferies, Brewer, and Gajendran 2014). This was also experienced in the Omaolo case. To be flexible with rules, regulations, collaboration and work practices, and individual working hours, the parties had to, for example, bend the competition rules and individual profitability goals – and to be completely honest and open with them. The overall transparency increased in the ecosystem. Whether this transparency and practices are sustainable remains to be seen. The need for including the public sector actors is, however, emphasized in the literature (Cojoianu, Haney, and Meiring 2020) and in our case.

1.5 CONCLUSION

In conclusion, adopting an alliance model in software ecosystems can significantly enhance the ecosystems' ability to respond to an emergency by emphasizing open communication, shared goals, and transparency. Aligning stakeholder resources and expertise and simplifying decision-making processes facilitates joint development and rapid innovation between

stakeholders. Furthermore, encouraging flexibility in organizational rules, work practices, and regulations can promote resilience and adaptability in crisis situations. Streamlining processes enables rapid response to changing demands and ensures the deployment of essential solutions. The common threat and a sense of urgency created genuinely new ways of working together to deliver welfare and healthcare software. These included maintaining communication and information sharing, combining agile development approaches with regulated medical software, streamlining processes, direct state funding, and existing deployment paths.

In doing so, enhancing transparency improves collaboration efficiency and trust among all stakeholders in digital ecosystems. The open sharing of information, progress, and challenges across all levels of partnerships, especially in crisis response, is crucial to enable rapid adaptation of solutions, pre-empt potential conflicts, and foster a culture of mutual accountability and collaboration.

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Enterprise Architecture as an Enabler for a Government Business Ecosystem: Experiences from Finland

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Abstract. Public sector procurement units in the field of ICT suffer from siloed, application-specific architectures, where each system operates in isolation from others. As a consequence, similar or even identical data is maintained in several different databases hosted by different organizations. Such problems are caused by the lack of standard guidelines and practices that would result in interoperable systems instead of overlapping ones. In the Finnish public sector, enterprise architecture (EA) is a mandatory requirement so that an ecosystem can be formed to overcome the above problems. However, the adoption rates are low, and the focus is often on technology rather than processes and practices. This study investigates the use of EA and its potential in Finnish procurement units through semi-structured interviews. Five procurement units and four vendors participated in the study, and altogether 12 interviews took place. As a result of the study, a practical implication is establishing decentralized project management practices in procurement units and enhancing leadership to establish a holistic EA. Furthermore, EA maturity evolution increases agility in the procurement unit.

Keywords: Public sector software · enterprise architecture · software procurement · business ecosystem · digital ecosystem · government business ecosystem.

1 Introduction

Public organizations follow procurement directives when procuring goods and services, including software. The implementation of procurement directives can vary nationally, and there are no international standards for purchasing software for the public sector. However, most procurement directives aim at ensuring transparency, fairness, and cost-effectiveness in the procurement process. Procurement directive generally includes vendor selection requirements, contract negotiations, and software management. For the latter, enterprise architecture (EA) is a commonly used tool that defines guidelines for how the public organization in question operates and uses IT and data. These guidelines then form the basis for a business ecosystem that delivers services to the public organization.

Ecosystem development is one of the cross-cutting priorities for developing strategic and responsible procurement practices in Finland [19]. By establishing ecosystem thinking, public procurers can pool their resources, relate to innovations taking place in businesses, and maximize their market power and impact. A business ecosystem is a network of interdependent, loosely interconnected organizations, individuals, and other entities that co-create value [11,1], by, for example, distributing goods and services [23]. The business ecosystem concept encompasses the entities that make up a business environment, including suppliers, customers, competitors, regulators, and other stakeholders [11]. These ecosystem actors have a specific position in the ecosystem; they are linked to each other and undertake activities to create and capture value in the ecosystem [1]. Each component of a business ecosystem affects and is affected by the others, creating a complex web of dependencies [23]. For example, changes in one ecosystem component, such as introducing new software, may cause ripples throughout the entire ecosystem and lead to changes in other components. Hence, a business ecosystem can be seen as a symbiotic, living organism constantly evolving and adapting to changes in its environment in a robust manner [23,11]. By examining the relationships and interdependence within the ecosystem, organizations can identify opportunities to respond to challenges and boost their performance.

In this paper, we identify the existence of different ecosystems such as digital ecosystems [5], software ecosystems [12] and digital platform ecosystems [8]. We generally concentrate on government business ecosystems where actors interact and transact to co-create value in the context of public procurement. As a concrete contribution, we present a study that examines the state of EA in the Finnish public sector, and its ability to facilitate a government business ecosystem. In this study, twelve semi-structured interviews are performed with actors that participate in building public sector EA and have a holistic understanding of what could be done to evolve further.

The rest of this paper is structured as follows. In Section 2, we present the benefits of mature EA compared to what business ecosystem creation demands. In Section 3, the research approach is given, and the research method is described. In Section 4, we present our results. In Section 5, we discuss the results, and in Section 6, we draw some final conclusions.

2 Background and Motivation

Characteristics commonly associated with the software include ease of deployment, modifiability, and scalability. The same code can be used in different organizations and different applications. A well-designed approach allows data sharing between other software systems, for instance. Hence, there is no need to re-produce similar software as long as the software components used are generic and reusable instead of monolithic applications.

In Finland, a certain level of national EA is mandatory, but practical implementations by different actors vary. Fundamentally, with roots in the Open Group Architecture (TOGAF) [6], recommendation JHS-179 [13] guides how to

describe an organization's EA. Unfortunately, while TOGAF is the most widely used EA framework, it has not been thoroughly adopted. In addition, the seminal Zachman framework for enterprise architecture [36] is recognized as the foundation of all EA frameworks. This study understands that the Zachman framework is well suited to describe the enterprise architecture of complex and large organizations [36]. However, in the public sector context, the Zachman framework is unsuitable for procurement units with little or no IT skills, whereas IT procurement in Finland is commonly carried out by employees whose daily job does not include IT. To this end, we prefer an approach that is intuitively accessible and presents all the interconnections between different roles effortlessly.

Unfortunately, outside the IT domain, procurement unit stakeholder groups fail to adopt EA artifacts in practice [30,22]. Public sector software sustainability issues can be overcome with EA, where different services and vendors can quickly deploy and integrate into the ecosystem environment [31]. Moreover, research performed with 26 practitioners in public agencies reveals that ecosystem thinking in EA software is still missing in practice, even though it is necessary [22]. Furthermore, Nurmi et al. [22] state that public sector EA should utilize the capabilities of the organizations which participate in the ecosystem, develop solutions in co-creation, hold a holistic view over EA, and have need-based EA modeling to enhance ecosystem formation.

Unfortunately, these viewpoints do not reveal how the public sector and vendors position themselves in the public sector digital ecosystem. An ecosystem, where every piece gives something, may be achieved with services that interact via well-defined APIs but with no direct access to other services [31]. Techniques in the system need to support systematic and fast development and deployment [31]. Moreover, public sector software suffers from vendor lock-in, high maintenance costs, and time-consuming and error-prone public tendering. In addition, need-based user utilization, co-creation, holistic view, and organizational capabilities are essential building blocks for public EA [22]. Modular business units [31][28] attached to the organization's core infrastructure help in this regard.

Improvements in IT efficiencies, such as standardized technology and technology management, lead to increased centralization in management [28]. The aim is to look forward to shared practices and infrastructure, reduce platforms, and raise cost-effectiveness. The organization's key benefits may require sacrificing some business unit needs [28,26,25]. Similar findings have been detected among Finnish municipalities. The comparison between the six largest cities in Finland showed that once IT governance becomes centralized and practices somewhat controlled, IT costs and personnel diminish by thirty percent [18].

As a part of digitization, fundamental organizational attitudes need reconsideration, in contrast to traditional processes. When a unit searches for new systems, the negotiating happens among accepted systems and platforms rather than defining a tailored solution and aiming for the best in the markets. Standardization brings new risks to management; the IT department must be on the nerve to monitor and upgrade the standards. Hence, the complexity of investment decisions rises. The top-management issues haunt hidden behind the prob-

lems mentioned above. If the EA lacks top-management sponsorship [30,29,9], it is demanding to receive the EA benefits such as cost reduction, IT standardization, process enhancement, and strategic differentiation [34]. The lacking leadership hinders EA process adoption. Furthermore, [30] recognize that EA practice demands specialized skills and capabilities to manage vast entities. The leader must have leadership and management skills and an understanding of the technical side of the entity. The following list summarises the benefits mature and well-managed EA for an organization:

- EA effectively manages IT assets and aligns IT investments and requirements in business [24,4,15,25,28].
- High maturity in EA is a prerequisite for agility in an organization [4,28].
- Ea maturity development enhances the formation of modular business units, where unit managers regain their power by giving them a greater choice to design front-end interfaces [27].
- Modular business units enable selective standardization by module [27], and cost-effective IS replacements [31].
- IT [27,18] and personnel costs diminish [18].
- Agility increases through EA, which builds on modular business unit information systems [31].

However, EA modeling seems insufficient in terms of digital ecosystem creation. Anwar and Gill [2] thoroughly analyzed the seven most common EA frameworks and discovered that the existing frameworks, such as TOGAF, provide tools to support the business and information layers, but not social and professional layers. In this research, we consider these layers to be of utmost significance. Moreover, it seems that existing frameworks could be combined to create a framework to offer a holistic view of EA in digital ecosystem creation [2].

Maneuvering complex ecosystem interdependencies demands organizations to move towards a more holistic and dynamic mindset, instead of concentrating on controlling the current resources [7]. The ecosystem approach introduces new requirements for structure and functions in value creation, in comparison to, e.g., networks, clusters, and innovation systems. However, understanding the complex ecosystem dynamics and system behavior is challenging [7,3]. In this research, we concentrated on evaluating the following characterization of ecosystems:

- Scalability via, e.g., greater integrability and standardization [32].
- Adaptivity via, e.g., open and adaptive resource integration [32].
- Shared alignment via, e.g., mutual agreement and compatible incentives [1].
- Dynamic nature via, e.g., improved agility [7].
- Higher interoperability in terms of multilateral connections [1].
- Partnership via, e.g., fostering collaboration and flexibility in control over the ecosystem [11].
- Value co-creation via, e.g., innovation [11].
- Service digitization as it is indispensable for ecosystem creation [32].

Table 1. Interview participants.

Organization	Abreviation	Position	Field	Duration
Vendor 1	V1	Senior Principal	ICT	49
Vendor 2	V2A	Head of department	ICT	49
Vendor 2	V2B	Specialist	ICT/Procurement	49
Vendor 3	V3	Chief position	ICT	45
Vendor 4	V4	Vice President	ICT/Sales	56
Procurement unit 1	PU1	Chief position	ICT	47
Procurement unit 2	PU2A	Manager position	ICT	48
Procurement unit 2	PU2B	Senior Specialist	ICT	62
Procurement unit 3	PU3A	Head of procurement	Procurement	63
Procurement unit 3	PU3B	Manager position	ICT	49
Procurement unit 4	PU4	Chief position	ICT	58
Procurement unit 5	PU5	Manager position	ICT	56

We realize that the above-mentioned characterization is not comprehensive, and that it is collected to observe public sector EA and ecosystem initiatives. In this research, we aim at recognizing how the ecosystem-creation inhibitors such as silo structure and rigidness [32], lack of robustness [7], low need for central control [11], high control over ecosystem [11], and high dominance in value [32] present themselves in public sector EA and ecosystem initiatives.

3 Research Approach

Research Setup and Data Collection. The participants selected for the study all have experience in public procurement practices and enterprise architecture development in the public sector. The goal was to find which kinds of relationships exist in ICT procurement between procurement units and vendors and how public sector EA guides this process. In some cases, the chosen organizations cooperated with each other or had collaborated previously. The upcoming changes in Finnish public sector infrastructure guide us to examine the state of Finnish public sector EA. The research question we seek to answer is:

How does enterprise architecture support digital ecosystem development in the public sector?

Semi-structured interviews were performed between November 2021 and May 2022. The initial literature search and media attention on the Finnish public sector IS project failures [16,35] presented points to be considered themes in the interviews. These themes were ICT vision, public procurement, financials, IS life cycle, know-how, and commitment. The themes guided the discussions, but the participants were encouraged to contribute what they felt was important. The interview duration varied from 45 min to 63 min. Sometimes intriguing topics need to be discussed more thoroughly. The average time was 55 minutes. Table 3 presents the participant info.

Data Analysis. All the interviews were recorded and transcribed. The identification data and the repetitions or when the interviewee or interviewer searched for the words were removed. Coding took place in Atlas.ti software's cloud version. The approach was inductive, and the phenomena in the data had

a guiding role. Hence, the initial coding and theme formation was data-driven, as well as intuitive and reactive [21], producing 99 initial codes, and 21 themes. Comparing the themes with literature, Ross et al. [28] four-stage EA maturity model began to make sense. This resulted in five themes; 1) information system procurement objectives, 2) procurement processes, 3) responsibilities and control, 4) perceptions of the legislative environment, and 5) EA solutions. These themes formulated bundles between the initial themes and codes, and Ross' [27] stages helped to understand the differences between the organizations.

However, some phenomena did not directly link to the Ross' [27] model. For these cases, the ecosystem literature revealed the next steps. To gain a more systematic and structured understanding of the public sector and vendors' position in ecosystems that take place in the context of public procurement, we used a domain-specific modeling language called Ecosystem Governance Compass [33] to model the ecosystem components, interactions, and dependencies. The language concepts were derived from literature and based on a holistic, dynamic system-based view of collaborative ecosystems [17]. The language objects were divided into four categories representing different aspects of ecosystem governance: governance, business, technology, and legal and regulatory context. Ecosystem Governance Compass announced places where the EA approach failed to interpret the results, which led to the creation of five additional themes: 6) higher sustainability components, 7) value co-creation, 8) shared objectives, 9) dynamic nature, and 10) holistic view. These ten themes revealed this research's key findings, where the EA and public sector procedures inhibit or facilitate sustainable ecosystem formation.

4 Results

Participants are presented with acronyms to introduce our results, where procurement units are PU1, PU2, PU3, PU4, and PU5. Vendors are V1, V2, V3, and V4. To make a difference between multiple participants from one organization, they are presented with letters A and B, for example, V2A and PU2A.

4.1 Government business ecosystem inhibitors

Most commonly used opportunities in public procurement guide towards a stiff waterfall-like development model. In this study, public agencies use open, restricted, and competitive negotiated procedures in ICT procurement. Open and restricted procedures are the most common ICT procurement procedures in Finland [10]. The competitive negotiated procedure leads to better IS procurement outcomes. In other public procurement procedures, the procurement unit must know precisely what they want and need before the tendering. Furthermore, negotiated procedures without tender hand-in-hand in-house procurement are considered emergency solutions.

Actors have no shared alignment. Sometimes the actors miss mutual agreement on goals, or their incentives are incompatible. The procurement unit

Table 2. Government business ecosystem formation inhibitors.

Characteristic	Ecosystem Related Characteristic
Most commonly used opportunities in public procurement guide towards a rigid waterfall-like development model.	Inhibitor for dynamic nature
Actors have no shared alignment	Inhibitor for shared goal and objectives creation
Immature EA and lack of control dynamic control	Missing collaboration and
Silo structure	Inhibitor for dynamic, adaptive nature
Vendor lock-in	Inhibitor for dynamic, adaptive nature
Budgeting IT expenses to the procurement units, the IT department	Inhibitor for holistic view

is searching for solutions to fulfill legislative tasks. Vendors are looking for new business opportunities, sales, and good word-of-mouth. PU1 and PU2 understand that interviewing the vendors is essential to know whether the common ground exists, whether the vendor is ambitious to engage in the development process, and whether the view over the issues is holistic. Besides monetary motives to engage in an ecosystem, the incentives should be something else too. However, these incentives are not easily detected in public organizations. Ideally, suppose the consortium of vendors builds the product (identification from one, databases from the other, operational control from the third). In that case, genuine cooperation is created to solve the problem of the procurement unit. Procurement units agree that the procurement act sets challenges to forming the above-mentioned coalitions. Tendering is error-prone, time-consuming, and difficult to predict outcomes. Therefore developing a genuine ecosystem-like and sustainable consortium is demanding, if not nearly impossible. Finally, tailored versus ready-made systems seems to divide opinions among vendors and procurement units. PU1, PU2, and PU3 recon that evaluating the purposefulness of the old processes and ways to work is vital when acquiring new systems to determine if something can be done more efficiently.

Immature EA and lack of control, silo structure and vendor lock-in. The governance of the public organization has a significant role in committing to the EA decisions. However, some of the interviews reveal that, in many cases, public organizations have immature enterprise architectures and inadequate leadership behind them. Public organizations that lack firm leadership to support EA initiatives tend to have a silo structure, where the procurement unit has lots of freedom to tailor solutions that fit one procurement unit. In these cases, the IT department remains in the dark about decision-making and purchasing. Furthermore, these organizations do not have EA units to cross-check the information system's interoperability and compatibility with the existing EA. PU3 has developed its practices and has an EA unit to cross-check the projects, IS, and budget. However, the leadership to put holistic EA thinking into practice is missing. PU3A depicts that every procurement unit leader needs to consider EA in mind, which is troublesome, and the actors are not coordinated optimally.

Hence, when the procurement unit purchases a system where compatibility with existing EA is not investigated, problems arise, such as silo architecture [32], vendor lock-in, data integrity, data management, and additional development hours leading to exceeding original budgets, to name a few common ones.

To overcome the data integrity problem, PU3 has determined master systems where the data can be edited. PU3 and PU4 have introduced an incentive to get rid of the solutions that are tailored to one unit, but only those information system purchases that exceed the national thresholds proceed to the EA unit's or project portfolio management's evaluation. In PU5, those information system projects that exceed national thresholds also demand upper-level decision-making. However, no one evaluates the new demand against the existing EA, which has caused a challenging situation in PU5. To this end, PU5 depicts in the interview that:

> *"We have 1400 information systems."*

Without established coherent EA practices, procurement units seem to create disposable EA for IS procurement. In PU5, even that failed. The acquired system in PU5 enables structured documentation and is used throughout the organization and in similar organizations in the area. However, PU5 has encountered difficulties in it:

> *"Two things where it fails; in the tendering phase, the organization's EA and the system's architecture were not evaluated, how they would fit. The second thing is leadership. In large entities, such as this system, the discipline should be in place to guide the development."*

PU4 describes that sometimes the IT department receives the information from the purchase afterward, even if the organization has set processes to inform the IT department on all IS-related purchases. PU4 does not have decentralized project management practices. Before the purchase, necessarily no-one maps out the budget and personnel resources. Even if the chain of command is not explicitly drafted, the actual purchasing is standardized in all public organizations. In this research, all public organizations have procurement teams or units, where experts help to prepare the procurement and are responsible for the tendering phase. The procurement units provide well-prepared procurement practices and tenders. The incentives are to avoid legal issues – especially the market court – and to offer vendors equal, non-discriminating tendering processes.

Vendors depict that resources in public organizations may limit which kind of systems are acquired. Smaller public organizations may not have the resources to go through the heavy public procurement in personnel, competence, and funding. The technology seems to be very flexible, and public organizations can get anything they wish for. V1 expresses concerns when the procurement unit outsources requirement analysis solely to the consultant. The vendor may help the procurement unit with technical requirement analysis, but the needs should emerge from procurement unit functions and objectives. Therefore, V1 is concerned when the procurement unit starts the procurement process with requirement definition

before the public procurement. It seems to waste resources, especially in cases when the system itself already exists in the market, but the public sector is not aware of it. In this situation, vendors would only need public organization guidance to understand what exists in their technical field already to avoid going to the path of tailored systems. Hence lack of knowledge of the existing technical field, in terms of compatibility and interoperability, guides vendors to produce tailored solutions if the EA is drafted only for the acquisition in hand. These characteristics describe the inefficient scalability adaptivity in an organization [32,22,30]. In addition, the environment is rigid and lacks robustness.

Budgeting IT expenses to the procurement units rather than to the IT department. Budgeting practices may inhibit coherent EA formation and enhance silo structure. Some public organizations distribute the expenses when the procurement unit administers the funds between its functions. It appears that this is not a viable solution and results in overlapping tasks and IS systems in the organization. There is a low need for interdependent relationships and centralization, which inhibit ecosystem creation [11]. Furthermore, it seems unthinkable that units which do not hold the competence to evaluate IS-related needs are responsible for IS budget and have the freedom to acquire whatever is wanted under the national threshold. This is the situation in PU3, PU4, and PU5; procurement units control the budget. These units suffer from vendor lock-in and have excessively locally tailored systems.

All procurement units have legislative tasks that guide service production in society. In Finland, norms such as the public procurement act and procurement directive obligate seeking the most advantageous offer through public procurement. Evaluating the most advantageous offer appear to cause issues for the procurement units. The narrative is apparent between the "old" way of evaluating the most advantageous offer and the "new" way.

PU3 is incentivized to evaluate the cost and quality of the business operations against the receivable benefits. However, the solutions are not assessed holistically against the EA, and EA is not managed top-down. In addition, different unit leaders are supposed to have a clear understanding of the EA. PU3A sees this as a problem. Some units have a clear picture, others do not, and the top management does not rule or guide them to acquire solutions that serve the whole organization. In PU4 and PU5, the current business objectives are towards reduced IT costs.

4.2 Government business ecosystem facilitators

Mature EA and sufficient control. Sufficient control enables EA practices throughout the organization. Moreover, research by Nurmi et al. [22] states that EA modeling should be need-based. In this research, PU1 and PU2 have top-down support for EA endeavors, which allows a coherent EA landscape. In PU1 and PU2, procurement units cannot purchase anything that suits only one unit's purposes. Hence, these two viewpoints, need-based EA modeling and top-down support, seem to coexist nicely in PU1 and PU2. In these units, operations guide

Table 3. Government business ecosystem formation facilitators.

Characteristic	Ecosystem Related Characteristic
Mature EA and sufficient control	Facilitator for dynamic and adaptive nature
Shared ambition to improve practices between the public organization and vendor	Facilitator for shared goals and objectives
Budgeting IS expenses to IT department	Facilitator for holistic view
Cooperation with universities	Interdependencies between stakeholders, Value co-creation and innovation creation

the needs, and the best practices to execute the solutions are holistically evaluated against EA. PU1 and PU2 seek efficient, predictable, and interoperable systems for their EAs. In addition, the procurement units that have top-down determined EA seem to have more uniform purchasing practices. PU1 aims to purchase systems as a service solution (SaaS) to the cloud rather than tailored software. PU1 depicts that they do not have even one developer in the agency and purchase all the software. PU1 has diminished the number of vendors significantly. At first, PU1 had nearly 100 vendors executing the information systems. Furthermore, many of the solutions had a price tag of just under 60 000€, which is the threshold that demands procurement. PU1 representative thinks these solutions were the result of unplanned spending and panic. In recent history, PU1 has then overcome technology standardization which diminished the number of vendors. PU1 has customized software besides the ready-made solutions, aiming to purchase reusable platforms with modifiable user interfaces. It enables PU1 to have standardized technology and keep the core optimized. PU1 shows minimal data and software duplicity, and the systems interoperate. PU4 depicts that the old ridged systems are replaced gradually with new systems, which creates the grounds for developing data management practices. Here, technology-enabled change is a stepping stone toward standardized technology.

Shared ambition to improve practices and make the change between the public organization and vendor. V4 has plans to scale the most popular product to the markets in a plug-and-play sort of system because market research shows that it is what procurement units want. V1 is interested in producing better systems that interoperate with local systems, enable standardized working environment units across Finland, and improve working habits. V1 depicts that it is not always easy to measure quality-related improvements, which may not manifest immediately but with time.

Budgeting IS expenses to the IT department. As mentioned earlier, budgeting practices may inhibit or facilitate ecosystem creation. PU1 and PU2 have centralized IS finance management. The procurement units do not control the IS budget. PU3 is transitioning to centralized IS budget management and revising IS budget management responsibilities as the old IS contracts change to new ones. In PU1 and PU2, the IT department is the financial gatekeeper and the buyer. If the system wished for is suitable with EA and otherwise advantageous, it proceeds to public procurement. This applies similarly to the IS under the national threshold, even if public procurement is unnecessary. This means,

for example, hardware or services under €60k. Public organizations which realize the benefits of centralizing some functions selectively, also understand that the cost at procurement may be an insufficient metric to evaluate the value generated with EA compatibility, planned lifespan expectancy, improved workflows, and knowledge management. PU1 depicts that sometimes the legislative tasks are mandatory but lack business cases. Here, the benefits cannot be measured directly with a cost-benefit analysis. Therefore, during ICT procurement, efficiency might seem ostensible, and the benefits may generate over time indirect ways. PU1 and PU2 determined that whatever is purchased needs to be evaluated and considered throughout. For example, PU2 depicts that a potential vendor lock-in does not matter, if it fits EA and is the best option available to solve the problem organization-wide. In these units, the benefit evaluation reaches from monetary evaluation to non-monetary assessment of the functions.

Cooperation with universities. Procurement units work with universities in research and development projects. PU3 depicts that the procurement unit may receive something that does not exist yet through these projects. For universities, cooperation offers real-world situations and problems to solve for students. PU3 depicts that:

> *"It was calculated that if one person does the recording work, it will take 5 years. Now we are collaborating with the university to develop a robot and artificial intelligence that can read, interpret and retrieve the right things from the drawings of the built environment and convert them into electronic form."*

Furthermore, collaboration with universities seems to enhance innovation. This facilitates co-evolving capabilities with actors [20] and hence, contribute interdependencies and enhance value co-creation in the ecosystem [22].

5 Discussion

In this work, we used Ecosystem Governance Compass to detect the government business ecosystem facilitators and inhibitors. As the result, we found out that ecosystem thinking is mostly missing from public sector EA and purchasing practices. In general, public sector software sustainability seems questionable, since the actors do not have compatible incentives for building up collaboration. In contrast, some public organizations have high-expertise units that form a genuine collaborative web, where every unit works towards similar goals, for example, coherent and efficient EA. However, in some public organizations, the shared goals are not identified [1], and working toward them systematically is missing. Public organizations that have identified the goals can develop solutions in co-creation with different units and vendors, which Nurmi et al. [22] have recognized as vital for public organizations to enable the formation of the digital ecosystem.

Holistic EA, controlled purchasing, and developing systems iteratively with vendors are signs of adaptivity in this research [32]. To consider government

business ecosystem formation, we realized that when the procurement units consider the procurement act to offer possibilities in the competitive dialogue and innovation partnership opportunities, these organizations could also selectively standardize [27] and scale solutions from across the organization [32].

The government business ecosystem helps to form a holistic view of EA for purchasing and budgeting, creating possibilities to scale solutions, and aiding co-creation and innovation within the ecosystem. Satisfaction towards management increases as the EA maturity evolves. Risk management, IT development time, and strategic business impacts improve, similar to the EA maturity benefits found by Ross [27]. The organization becomes dynamic. Furthermore, procurement units that have created precise and disciplined EA practices do not waste resources in information system procurement by creating disposable EA.

In contrast, procurement units that struggle to establish EA also struggle to form a government business ecosystem. These organizations have silo structures [32], where different procurement units can determine which solutions to acquire, and the control is insufficient. Vendor lock-in exists in many places, and public procurement is often seen as a risk of receiving a solution that does not comply with the needs. Furthermore, units with silo structures are missing holistic comprehension of the IT landscape in the organization. The budgeting supports this. The procurement units control the budget, including IS-related purchases, which leads to a situation where the shared incentive to build holistic EA is missing. In this case, the procurement unit purchases and solves problems that concern only one unit.

Exploring EAs in procurement units reveal that the EA initiatives exist in all participating procurement units, even if they might not be visible in practice. In theory, they exist. Some of the results are similar to Seppänen et al. [30], and Nurmi et al. [22], who discovered low EA adoption rates in Finnish public sector EA. In this study, procurement units with disciplined decision-making practices are higher in EA maturity. The leadership shows throughout the organization, and the strategy exploits the EA practices and purchases.

The changes are slow in public sector. Hence, to overcome and dissolve the challenges such as silo structure and vendor lock-in, we trust that the EA approach combined with the ecosystem mindset could help the public organizations to gain a more holistic view of their functions. In particular, modeling tools such as Ecosystem Governance Compass provide an excellent way of describing the formation of a holistic relationship-based ecosystem. Furthermore, Nurmi et al. [22] suggest a centralized EA repository that would update in real-time. This could help national efforts to create a single, interoperable EA.

Threats to validity. The research method, semi-structured interviews, allowed the interviewees to depict what was relevant to them. However, this might be a weakness as well [21], as the data set was large. Luckily, we had expertise from the University of Jyväskylä to contribute to Ecosystem Governance Compass, which helped us to combine complex phenomena in EA and government business ecosystem creation. The data collection and analysis follow Myers [21] semi-structured interviews and thematic analysis guidelines. Data is collected

and analyzed iterative way and rigorously, which makes the study's reliability high. However, the researcher's interpretation may have affected the results because the initial coding was intuitive and interpretive. Myers [21] depicts that inner validity could be improved with triangulation or multiple researcher evaluation. In this research, the authors collaborated to analyze and discuss the categorizations of the codes. The results describe facilitators and inhibitors for the government business ecosystem. Interestingly, the results suggest that EA development in public organizations is at very different stages, which may affect the generalisability of the results. In this study, we do not distinguish EA maturity levels in public organizations.

6 Conclusion

In this study, we have analyzed if EA acts as an enabler for a government business system in Finland. As a tool for analysis, we used Ecosystem Governance Compass to recognize factors that either facilitate or inhibit government business ecosystem creation. As a result, the facilitators are mature EA and sufficient control, shared ambitions, centralized IS budgeting, and cooperation with universities. The inhibitors are the insufficient choice of procurement opportunity, not sharing goals and understanding, immature EA and lack of control, and lack of selective centralization in IS budgeting. The leadership and top-down support for EA practices are highlighted – the more mature the EA, the firmer leadership and top-down support. Furthermore, all procurement units in this study have adopted one EA section, standardized purchasing, and use a multi-talented procurement unit or team which prepares the call for tender. However, a hinder to agility lies in the practice before the procurement proposal reaches procurement personnel. Higher EA maturity procurement units have decentralized project management, which is missing from the lower EA maturity procurement units.

In conclusion, future EA frameworks and practices seem to lean on modular business units in an ecosystemic environment. However, the changes are difficult to implement nationally because each organization acquires services only for itself. However, modeling can imitate the chosen standards, and, with approaches such as openEHR [14], may be practical to combine accurate modeling and serving user needs in detail. However, more research is needed, because such modeling has scarce scientific literature and empirical results.

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