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AI-driven public administration: mitigating sludge and biases in Estonia's and Singapore's digital governance

Supervised by Prof. Riccardo Viale

Blerta Dobërdolani

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Thesis Pitch

https://youtu.be/xSdjBkfnysM

Statutory Declaration

I hereby declare that I have composed the present thesis autonomously and without use of any other than the cited sources or means. I have indicated parts that were taken out of published or unpublished work correctly and in a verifiable manner through a quotation. I further assure that I have not presented this thesis to any other institute or university for evaluation and that it has not been published before.

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Dobërdolani Blerta

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Abstract

This thesis explores the influence of artificial intelligence (AI) in public administration based on behavioral effects, sludge, and biases by using qualitative case studies of Estonia and Singapore. It addresses the research question; how AI affects Estonian and Singaporean public administration and the sub-questions; how AI influences bureaucratic and citizen behavior, to what extent it minimizes or contributes to administrative sludge, and how algorithmic biases are being addressed. The study integrates theoretical frameworks (nudge theory, behavioral economics, AI ethics) and empirical findings. Estonia's e-Estonia program and Singapore's Smart Nation initiative illustrate the potential of AI to streamline citizens' engagement and eliminate sludge through automation but also pose issues such as automation bias and digital exclusion. Algorithmic biases, fueled by under-representative data sets, are tackled by transparency in Estonia and by ethical principles in Singapore. Comparative analysis yields context-specific results, with centralized government facilitating Estonia's responsiveness and Singapore's diversity requiring effective coordination. The findings refine sludge theory, uncover automation bias in high-trust environments, and contribute to AI fairness studies. Policy solutions involve inclusive design, human oversight, and ethical regulation to trade off efficiency and equity. Although case specific, the research provides real-world applications for governments implementing AI, making contributions to public administration and behavioral economics research. Future research needs to examine first-hand data and various settings to further clarify the consequences of AI for the governance context.

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Chapter 1: Introduction

1.1 Background and context

Increasing adoption of artificial intelligence (AI) within public administration is reshaping governance with enhanced efficiency, streamlining of services, and data-driven decision making (Misuraca & van Noordt, 2020). Whether applied to predictive health analytics or automated taxation and social welfare decision making, AI technologies are reshaping how governments interact with citizens and allocate assets (Sun & Medaglia, 2019). Governments globally utilize AI to address deeply entrenched social problems, including aging populations, urban congestion and resource allocation. Public investment in AI is expected to grow because its use in the everyday life, starting from healthcare to transportation is moving fast (Maslej et al., 2025). Canada applies AI for immigration screening, for instance, and Sweden for labor market services, demonstrating applicability of technology to various needs (Engstrom et al., 2020; OECD, 2021). However, adoption of AI in public administration is burdened with severe difficulties from unwanted behavioral effects and bureaucratic inefficiency to so-called "sludge" and algorithmic bias capable of undermining equity, trust, and justice within government (Thaler, 2018; Binns, 2018). As governments respond to this technology change, understanding of AI's multifaceted effects is key to crafting systems productive and ethically sound at once.

1.2 Research focus and dimensions: Behavior, sludge, bias

This thesis examines how AI affects public administration on three interrelated axes: behavioral effects, sludge, and biases. Behavioral effects refer to how AI affects citizens' and bureaucrats' actions and perceptions. For example, automation bias; over-reliance on decisions taken by AI will change decision-making dynamics, and AI-powered services can either reinforce trust in government institutions or destroy it (Binns, 2018). For healthcare, for instance, AI systems meant to predict patients' needs can promote active behavior among citizens, but threaten an excessive reliance on technology (Desmal et al., 2023). Sludge, the term, coined from behavioral economics,

pertains to unnecessary administrative obstacles burden access to service, and taking various forms: overly complicated forms, lengthy processes, and cryptic systems (Thaler, 2018). Although by reducing routine tasks, AI promises less sludge, seen in smoother taxation systems, badly conceived interfaces or digital exclusion can create new sludge instead (Sunstein, 2022). Biases in algorithms, resulting from bad data and bad design, raise ethical questions by reproducing existing inequalities within public decision-making processes for serving citizens and implementing policies (Engstrom et al., 2020). For instance, discriminatory AI models applied to scoring credits, social services, and other public services can disproportionately hit groups already on the margins, raising essential questions regarding justice and accountability. Through an understanding of these dimensions, this research aims to provide a multifaceted view on how transformative AI can be for public administration, yet how problematic it can be.

The study's applicability is timely from its focus on how governance today is impacted by AI, with governments globally accelerating adoption. Globally rising investment in AI underscores the need for managing its behavioral, administrative, and ethical consequences. Literature shows the efficiency gains from AI while often overlooking behavioral effects, such as automation bias's impact on populations' or bureaucrats' decision trust (Sun & Medaglia, 2019). Similarly, AI's potential for reducing sludge is abundantly documented, while reducing obstacles like digital literacy frictions is less so (Sunstein, 2022). Moreover, algorithmic bias forms an inherent problem, with studies calling for resilient governance mechanisms to ensure equity (Engstrom et al., 2020). This thesis bridges these shortcomings by examining how AI shapes behavior, reduces or amplifies sludge, and manages ethical questions across different governance settings. Implications seek to inform policymakers on how to engineer systems of AI for enhancing public administration while avoiding hazards and, from academia's side, shed light on AI ethics and pragmatic policies on equitable service delivery governance.

1.3 Case study selection

The study focuses on two pioneering case studies, Estonia and Singapore, chosen for their leading roles on AI-enabled public administration and varying governance systems. Estonia, a small,

homogeneous European state, is a global leader on e-governance with its strategy of e-Estonia, applying AI to healthcare, taxation, and citizens' services (e-Estonia, 2023). AI-enabled chat bots and predictive analytics, for example, make services easier to access, reduce sludge and enhance citizens' interaction but also raise questions on automation bias and data privacy (Desmal et al., 2023). Estonia's centralized and technologically advanced structure offers an ideal case study on how AI lessens administrative friction within an integrated system, yet its relatively homogeneous populace limits analyzing on diversity-related biases.

Singapore, an urbanized multicultural Asian city-state, has embraced AI with its Smart Nation strategy, putting it into healthcare, long-term care, and transport for tackling social issues like an aging population (Smart Nation Singapore, 2024). Its deployment of predictive analytics and autonomous systems provides proof of efficiency improvement and also underscores vulnerability to biases, particularly in multicultural societies wherein data differentials exacerbate widening inequalities (Zhang, 2024). Singapore's top-down state and multicultural context pose another type of case from Estonia's, offering complementary insights on AI's impact.

They were chosen due to the following reasons. First, both are leaders in AI adoption, with rich and documented examples of public administration applications for AI (Wirtz & Müller, 2019). Estonia's e-governance, with over 99% of public services online, demonstrates AI's potential to displace sludge, and Singapore's strategic investments in AI show its contribution to delivery of hard social demands (e-Estonia, 2023; Smart Nation Singapore, 2024). Secondly, their contrasting governance systems; Estonia's bottom-up and decentralized and Singapore's top-down and centralized system-allow for comparative observation of how effects of AI vary by institutional and cultural circumstances (Misuraca & van Noordt, 2020). Moreover, both have established governance arrangements for regulating AI's ethical dimensions, such as reducing bias and ensuring openness, offering valuable lessons for other governments (Allen et al., 2025). Focusing on concrete applications for AI, such as Estonia's health-related AI and Singapore's long-term care-related AI, this study offers actionable lessons on effects on behavior, avoiding sludge, and tackling bias.

1.4 Research question

This study addresses the following question and three sub-questions:

How does public administration in Singapore and Estonia get affected by AI?

1. How does AI influence citizen and bureaucratic behavior in public administration, particularly in terms of automation bias and trust dynamics?

2. How far does it reduce or create sludge within government operations and which factors are its determinants of success (e.g., system design, accessibility to users)?

3. In what ways are governments learning to identify and minimize algorithmic biases in AI-driven public services, and how does it influence fairness and accountability?

In order to address these, the thesis adopts a qualitative comparative case study approach, informed by document analyses of government reports, policy reports, and academic writing, supplemented by secondary data on applications of AI (Yin, 2018). It has three objectives: (1) to assess the behavioral impact of AI on citizens and bureaucrats, (2) to look at its ability to decrease or create sludge, and (3) to look at how biases can be minimized in AI-governance. Drawing on comparisons between Singapore and Estonia, the study aims to extract context-specific lessons and transportable insights for public administration.

1.5 Thesis structure

This thesis is structured according to the following order: Chapter 2 sets out literature on AI for public administration regarding behavioral effects, sludge, and biases, and identifies areas of research gaps. Chapter 3 describes the research methodology, rationalizing the case study and explaining data collection. Chapter 4 covers case descriptions of Estonia and Singapore, examining AI's impacts from a behavioral effect, sludge, and biases perspective. Chapter 5 combines findings from a comparative perspective, examining theory and practice implications. Chapter 6 wraps up with key findings, policy recommendations for inclusive adoption of AI and directions for future research on developing AI-enabled governance.

Chapter 2: Literature review

Usage of artificial intelligence technology has revolutionized public administration systems globally, enhancing efficiency, optimizing service provision, and informing decision-making based on data (Misuraca & van Noordt, 2020). Machine learning, natural language processing, and predictive analytics are some of the applied AI technologies utilized in taxation, welfare, health, and public participation, with prospects to revolutionize public services (Van Noordt & Tangi, 2023). For instance, Estonia's e-governance system utilizes AI for chatbots to make it easier for citizens, and Singapore's masterplan for a smart nation utilizes predictive analytics for health (e-Estonia, 2023; Smart Nation Singapore, 2024). Implementing AI, however, entails tremendous tests such as unintentional behavior consequences, bureaucratic inefficiency (termed "sludge") and algorithmic bias to detract from equity, trust, and fairness (Thaler, 2018; Engstrom & Ho, 2020). These are particularly relevant to diverse governance environments like Estonia's digitalized centralized governance and Singapore's multicultural intelligent governance.

This literature review examines AI's multifaceted impact on PA through three sub-questions: (1) How does it influence bureaucratic and citizens' behavior? (2) To what extent does it remove or generate sludge in administrative processes? (3) What specific biases does it generate in PA systems? Using 2018–2024 research and informed by seminal works, this review provides a theoretical and empirical foundation for investigating AI's impact on Estonia and Singapore. It pinpoints research gaps, places the thesis's contribution within scholarly and policymaking discourse, and provides a framework for making sense of AI's deployment in governance today. Organized by theoretical lenses, thematic analyses of sub-questions, syntheses of findings, and an exploration of research gaps, this review is tailored to meet the thesis's comparative case study design.

2.1 Theoretical framework

A study of artificial intelligence's (AI) impact on public administration (PA) has to be based on theoretical frameworks that encompass behavioral effects, access barriers, and biases of the technology. Nudge theory, developed by Thaler and Sunstein, makes distinctions between

"nudges" (actions that facilitate desired behavior) and "sludge" (barriers to access or effectiveness) (Thaler, 2018; Sunstein, 2022). AI in public administration can be both a nudge in process simplification, for example, Estonia's e-taxation platform, and create sludge in the form of complex interfaces, for example, Singaporean healthcare systems for older patients (e-Estonia, 2023). In assessing the extent to which system design could facilitate greater user interaction or serve as a barrier, nudge theory provides a theoretical framework for analyzing the effect of AI on user actions and administrative processes.

Algorithmic fairness, as offered by Binns (2018), presents an analysis of bias in artificial intelligence systems and lays out major fairness, transparency, and accountability principles. The model applies especially in the evaluation of the fairness of an AI within multicultural environments such as Singapore, whereby data imbalances may exacerbate existing gaps (Zhang, 2024). Principal-agent theory accounts for bureaucratic action and the transfer of decision-making authority from human administrators to algorithmic systems with the potential to restrict autonomy and cause a variety of biases, i.e., automation bias (Busuioc, 2021). An example of this is in Estonian healthcare analytics, wherein administrators are becoming ever more reliant on AI output and therefore redefine their decision-making role (Nõmmik, 2025).

Based on the theory of organizational change, explained by Kankanhalli et al. (2019), resistance to adopting artificial intelligence (AI) can come from a lack of skills, organizational barriers, or perceived threat to current job roles, which are issues evident within public administration practice in Singapore (Smart Nation Singapore, 2024). In parallel, diffusion of innovations theory examines how public administration systems disseminate AI technologies based on perceived usability and compatibility factors (Sun & Medaglia, 2019). These theoretical concepts are the bases for analyses included herein and find connections between theoretical observation and applied examples from Estonia's e-governance and Singapore's smart nation initiative, and hence form a foundation for a complete understanding of the behavioral, administrative, and ethical implications relating to AI.

2.2 Behavioral effects of AI in public administration

AI deployment in PA systems affects the behavior of public officials and citizens significantly, driven by efficiency gains but tempered by concerns about trust, accessibility, digital literacy, and

organizational adjustment. For citizens, AI-powered interfaces such as chatbots and e-governance portals facilitate better access to public services, encouraging the use of digital channels (Zuiderwijk et al., 2021). Estonia's AI-driven chatbot “Kratt” facilitates better interaction with public registries, making it convenient for citizens to access services like business registration or health records, with less effort required, with over 99% of public services available online (e-Estonia, 2023). Van Noordt and Tangi (2023) demonstrate that automatic tax support systems enhance performance, encouraging online participation, like Estonia’s tax e-filing system, where 95% of returns are filed online. Similarly, Singapore's AI-driven healthcare services, such as patient triage predictive analytics, facilitate pro-active participation by providing personalized recommendations (Smart Nation Singapore, 2024).

Technical hurdles, however, introduce diverse behavior. Pencheva et al. (2020) note that less technologically skilled users, such as elderly or rural citizens, are discouraged by the unavailability of AI systems and therefore present avoidance behavior. Estonian rural citizens cannot handle digital platforms despite superb digitalization, decreasing participation (Salumaa Lepik & Nisu, 2024). Singaporean digital divides among poor or elderly citizens limit access to AI-enabled services, introducing issues about equity (Sousa et al., 2019; Zhang, 2024). Agarwal (2018) notes that simplicity in AI can introduce overdependence, diminishing important interaction with public services, a drawback in the highly automated system of Estonia where citizens may not critically analyze AI outputs (e-Estonia, 2023).

For administrators, AI transforms professional labor by automating decision-making and data processing, creating a diversion of attention from manual processing to strategic management. Pencheva et al. (2020) argue that AI processing of large datasets enhances efficiency, as seen in Estonia’s predictive analytics for healthcare resource allocation, making it possible for administrators to do more policy design prioritizing (Tiik and Ross, 2010). In Singapore, AI in long-term care systems enables public administrators to deal with complex cases, reducing administrative burden (Smart Nation Singapore, 2024). However, this reliance has the automation bias effect, where administrators over-rely on AI responses rather than scrutiny (Busuioc, 2021). For example, Singapore’s AI healthcare systems require human verification to prevent mistakes, while over-trust reduces diligence (Zhang, 2024).

Resistance to the use of AI is another behavioral problem. Madan and Ashok (2023) enumerate skills deficits and fear of job loss as problems, namely in Singapore's public administration, where administrators who are not acquainted with AI resist new systems. Cultural acceptance in Estonia is divided between younger administrators being more accepting of AI and older administrators fearing job loss (Salumaa Lepik & Nisu, 2024). Zuiderwijk et al. (2021) emphasize system transparency as being key to trust, as non-transparent AI systems cause disengagement. Estonia's transparent e-governance reduces some of the trust issues, while Singapore's multicultural workforce emphasizes inclusive training (e-Estonia, 2023; Smart Nation Singapore, 2024).

Literature indicates a dual impact: AI enhances efficiency and interaction but poses barriers in trust, ability, and access. Sun and Medaglia (2019) suggest user orientation and transparency as a way of mediating the impacts, findings applicable to Estonian centralization and Singapore's multicultural population. Agarwal (2022) calls for scrutiny of AI's emotional impact, such as frustration triggered by technical obstacles, particularly for vulnerable groups, with an emphasis on equitable adoption of AI.

2.3 AI and sludge in public administration

Sludge, or administrative friction that hinders service delivery to citizens, is an important lens with which to view AI's impact on PA (Thaler, 2018). AI reduces sludge by automating time-consuming procedures, such as data verification and application processing, making citizens and administrators more efficient (Medaglia et al., 2023). In Estonia, AI-driven tax systems automate submissions, reducing bureaucratic delays and cognitive effort, with 98% of tax returns submitted electronically and citizens saving an estimated 15 hours a year per submission (e-Estonia, 2023). Singapore's AI-driven healthcare systems automate patient information processing, reducing administrative burden and enabling timelier service delivery, with hospital waiting times reduced by up to 30% in some cases (Smart Nation Singapore, 2024). Van Noordt and Tangi (2023) note that AI chatbots, such as Estonia's "Kratt" and Singapore's healthbots, speed up service delivery, reducing user effort and waiting time.

However, poorly designed AI systems create sludge, undoing gains in efficiency. Engstrom and Ho (2020) argue that opaque algorithms with incomprehensible decision logic annoy users because

time must be expended to correct errors or decipher outputs. In Singapore, complex AI interfaces in long-term care systems confuse older users, leading to digital exclusion and extra mental load, particularly for the less digitally literate (Allen et al., 2025). Pencheva et al. (2020) observe that highly technical designs deter vulnerable users, a concern in Estonia where rural residents are deterred from using digital platforms despite high degrees of digitalization (Salumaa Lepik & Nisu, 2024). Medaglia et al. (2023) emphasize that unintelligible AI systems create mental loads, such as coping with errors in welfare systems, wiping out efficiency gains. For example, global case studies illustrate that AI-enabled welfare systems plagued with errors take users significant amounts of time to solve problems, creating sludge (Engstrom & Ho, 2020).

Sunstein (2022) indicates that sludge impacts marginalized communities worse. This is an issue in Singapore's multicultural society, where barriers to reading or language issues make services more difficult to access. In Estonia, simplifying interfaces reduces some sludge but still causes issues for rural and older users (Nõmmik, 2025). According to Kankanhalli et al. (2019), issues such as being resource-constrained or not user-centric impact the extent to which AI can cut sludge. This is significant in Singapore's public sector, where resource constraints influence the ease of systems to use (Allen et al., 2025). The research indicates two perspectives: AI can cut sludge through automation but could cause more issues if poorly designed or difficult to use. Estonia's robust e-governance is the best case of effectively cutting sludge, but attempts in Singapore for inclusivity indicate issues remain (Misuraca & van Noordt, 2020).

For effective use of AI, easy-to-use interfaces and clear guidelines are required. It is recommended by the OECD (2021) that governments invest in digital skills education and collaborate with users to develop user-friendly AI. Estonia's e-governance education and Singaporean public forums demonstrate how this can be achieved (e-Estonia, 2023; Smart Nation Singapore, 2024). These concepts emphasize making AI according to its given context to minimize issues and maximize benefits.

2.4 Biases in AI-driven public administration

AI also introduces cognitive and algorithmic biases that undermine the quality, fairness, and accountability of PA decision-making. Overconfidence bias, where AI results are relied on too

heavily by users, is a serious problem. Busuioc (2021) suggests that administrators using predictive analytics, such as Singapore's healthcare risk assessment frameworks, may rely too heavily on AI's accuracy and underplay data or algorithmic issues. In Estonia, unquestioned reliance in AI-processed healthcare information can lead to misdistribution of resources, particularly where the quality of the data is unbalanced (Tiik and Ross, 2010). Wirtz et al. (2022) argue that black box AI worsens overconfidence by hiding limitations, an issue in both countries where AI is the source of governance. For example, Singapore's AI-based credit scoring algorithms have been criticized for overreliance on biased data that generated discriminatory outcomes (Umeaduma et al., 2025).

The control illusion bias occurs due to the perception by administrators that they stay in control of AI-generated data with diminished agency. Young et al. (2019) identify administrators applying AI to assess risk in Singapore's social services with a sense of control while decision-making is relegated to algorithms, with gaps in accountability as the outcome (Smart Nation Singapore, 2024). Bullock (2019) identifies such issues in Estonia's welfare systems, where outputs from AI must be reviewed by humans, but the illusion of control for administrators increases errors. This bias precludes accountability, particularly in high-stakes use such as welfare eligibility or healthcare prioritization (Engstrom & Ho, 2020).

Inattention bias (selective attention) is generated as users delegate vigilance to AI systems, lowering diligence. Some note that Estonia's computerized welfare eligibility systems lead administrators to overlook anomalies, solidifying systematic mistakes. In Singapore, citizens may fail to challenge AI-output decisions, for example, credit risk or social services quotas, which solidify inequalities, particularly for marginalized groups (Zhang, 2024). Wirtz et al. (2022) note that inattention reinforces biases, threatening fairness and accountability. Inattention blends with behavioral effects and sludge: overconfidence increases tolerance for complex interfaces, whereas inattention solidifies disengagement with incomprehensible systems (Sunstein, 2022).

Literature demands robust governance systems to curb biases. Estonia's open data policy, as well as Singapore's AI ethics guidelines, are set to counter these risks, but there are remaining gaps (e-Estonia, 2023; Smart Nation Singapore, 2024). Criado and Zarate (2022) argue that stakeholders' inputs on ethical AI frameworks are necessary to be just, which Singapore achieves through public engagement. Cordella and Tempini (2023) highlight that there must be more research on power

disparities via biases, particularly in multicultural environments such as Singapore. Janssen and Kuk (2022) advocate for quantitative methods to calculate bias effects across welfare and regulatory domains to guide mitigation.

2.5 Synthesis and practical implications

The literature characterizes AI's dual role in PA as both transformative and challenging. Efficiency and engagement with process automation and digital participation improve through AI, such as Estonia's e-governance chatbots and Singapore's healthcare analytics (Zuiderwijk et al., 2021; Van Noordt & Tangi, 2023). Lack of transparency, skills gaps, and technical faults, particularly among vulnerable populations, create disengagement and resistance (Pencheva et al., 2020; Madan & Ashok, 2023). AI reduces sludge through automation, simplifying tax and healthcare systems, but causes frictions through complicated or opaque interfaces with unequal effects on marginalized groups (Medaglia et al., 2023; Engstrom & Ho, 2020). Overconfidence, illusion of control, and inattention biases compromise fairness, amplify sludge, and further disengagement (Busuioc, 2021; Wirtz et al., 2022).

These effects are synergistic: overconfidence generates tolerance for sludge, with uncritical administrators embracing complicated AI output, and inattention fostering disengagement, suppressing user resistance against biased determinations (Sunstein, 2022). Estonia's open, centralized e-governance system improves some concerns, open data strategies fostering trust and reducing sludge (e-Estonia, 2023). Singapore’s multicultural populace highlights the need for inclusive AI design, continuous attempts aiming to counter digital divides and bias through ethics guidelines and public engagement (Smart Nation Singapore, 2024). The literature suggests user-centered design, transparency, and robust governance are necessary to balancing AI advantage and risk, findings directly transferable to the case studies.

At a practical level, governments must invest in digital capability, co-create AI solutions, and establish transparent governance mechanisms in a bid to harness the benefits of AI (OECD, 2021). Estonia's rural upskilling programs and Singapore's public involvement are indicative of such solutions, though challenges like resource constraints, as well as cultural resistance, exist (Salumaa Lepik & Nisu, 2024; Zhang, 2024). The integration calls for context-specific intervention since

Estonia's centralized, homogeneous system is different from Singapore's top-down, multicultural type of governance that impacts AI in varying manners.

2.6 Research Gaps

Despite extensive studies, remaining literature gaps regarding AI's impacts on PA include Agarwal's (2018) call for more studies on AI's social and emotional impacts on citizens, such as frustration or alienation because of technical issues, especially for marginalized citizens such as Singapore's poor or aging citizens. Sousa et al. (2019) point to the need for studies on digital divides among marginalized citizens, such as Estonia's rural citizens and Singapore's multicultural citizens. Kankanhalli et al. (2019) note that organizational factors, such as cultural resistance or resource constraints, influencing sludge and AI adoption remain understudied, particularly in Estonia's central government where interagency coordination is unbalanced.

AI sludge long-term study is lacking, constraining knowledge of AI's administrative long-term impacts (Misuraca & van Noordt, 2020). For example, what are the impacts of sludge from complex AI interfaces on long-term user satisfaction with AI? Bias research necessitates quantitative methods to quantify effects across welfare, healthcare, and policing sectors, and cross-disciplinary methods linking behavioral science and data science (Janssen & Kuk, 2022; Vogl et al., 2020). Cordella and Tempini (2023) urge the investigation of power imbalances created by AI bias, particularly in multicultural settings like Singapore where algorithmic choices can perpetuate inequalities. Sun and Medaglia (2019) suggest comparative studies between countries to ascertain variation in context, a knowledge gap this thesis addresses by studying Estonia and Singapore.

There are also gaps, including a shortage of information about how trust in AI evolves over time among citizens, especially high-trust countries like Estonia. There is also not much investigation of how citizen participation affects AI governance. Singapore does this, but it needs to be given more thought (Allen et al., 2025). These gaps show the need for comparing and bringing together different fields of research. The goal of this thesis is to fill this gap by researching how AI affects behavior, poses challenges, and produces biases in different governance settings and testing ways to address these problems.

Literature demonstrates that AI in public administration can improve how things work, involve people more, and come up with new ideas, but also creates problems like mistrust, obstacles, and discrimination. Theories like nudge theory, algorithmic fairness, principal-agent theory, and organizational change theory interpret these effects. Estonia's e-governance and Singapore's smart nation plans are real cases to consider these issues. Estonia's openness minimizes obstacles, while Singapore's diversity recognizes problems with inclusiveness. This thesis will help to fill gaps in research by using a case study to improve our knowledge about AI in public administration. It will also help in the governance versus technology debate. Finally, it will help in designing fair policies for public administration based on AI.

Chapter 3: Methodology

This chapter introduces the research design and methodology for exploring the impact of artificial intelligence (AI) on public administration, with emphases on behavioral impacts, sludge, and biases, by using a comparative case study between Estonia and Singapore. The research methodology is structured to address the research questions and sub-questions: How does AI influence public officials and citizens behavior in public administration? To what extent does AI reduce or increase administrative sludge? How are algorithmic biases identified and managed in AI-driven public services? A qualitative comparative case study approach is used to develop an in-depth understanding of the multifaceted impact of AI in two varied contexts of governance. This chapter discusses the research strategy, justifies the selection of Estonia and Singapore, outlines data collection approaches, and lays the groundwork for the analytical framework and limitations so that research is systematic and rigorous.

3.1 Research approach

This study employs a qualitative, comparative case study approach to investigate AI's impact on public administration. Qualitative approach is appropriate to analyze complex phenomena like behavioral effects, sludge, and biases because it offers the prospect of detailed analysis of contextual factors and actors' experience (Yin, 2018). Comparative case study approach enables detailed analysis of the applications of AI in two contrasting environments, Estonia and Singapore, and offers the potential to uncover patterns, divergences, and context-dependent results (Stake, 1995). This approach is congruent with the thesis's aim to explore how AI impacts public administration in two contrasting models of governance, with emphasis on behavioral, administrative, and ethical issues.

The comparative approach involves studying AI's application in Estonia's centralized, digitally advanced e-governance regime and Singapore's intelligent, strategic governance system. By comparing a homogenous, small European country to a multicultural, urban Asian city-state, the study records variation in the behavioral effects of AI like citizens' trust and automation bias, sludge

like administrative friction, and biases like algorithmic fairness. The qualitative approach sacrifices breadth in favor of depth and uses secondary data to ensure research viability within the scope of a thesis project while maintaining rigor by undertaking systematic examination.

3.2 Justification for case selection

Estonia and Singapore were selected as case studies due to their global leadership in AI-based public administration, multiple governance environments, and proximate applicability to the thesis issues. Estonia, recognized as one of the world's most advanced digital society, has embraced AI in its e-governance, with applications in healthcare, taxation, and citizens' services (e-Estonia, 2023). Its small population (1.3 million) and centralized digital infrastructure provide a concentrated test bed to explore the impacts of AI on sludge removal and citizen conduct, and its data-based systems raise issues of algorithmic bias, particularly against minority groups.

Singapore, a smart governance leader, applies AI across healthcare, transportation, and long-term care, backed by national agendas like the Smart Nation program (Smart Nation Singapore, 2024). Its population of multiple races (5.9 million) and top-down system of governance provide another scenario in which to explore AI's behavioral influence across population categories and its capability to reduce or exacerbate sludge in large bureaucracies. Singapore's proactive approach to AI ethical governance also offers the potential to explore reducing bias, an issue central to this research.

These nations are selected because they have high take-up of AI, providing sufficient data for the analysis of behavioral impacts, sludge, and biases. Their variations in characteristics: Estonia's small-scale, citizen-centric model and Singapore's large-scale, strategic model, enable robust comparative examination, while their institutional contexts and cultural contexts strongly impact the influences of AI. Both countries also possess highly documented AI projects, ensuring good quality secondary data, a component that is critical in a time and resource-constrained thesis.

3.3 Data collection methods

The data collection mainly uses secondary sources to facilitate and achieve the thesis. The methods used are as follows:

1. Document analysis: official reports, policy documents, and government reports of Estonia (for example, e-Estonia briefings and Ministry of Economic Affairs and Communications reports) and Singapore (for example, Smart Nation strategy documents and Infocomm Media Development Authority reports) contain express information on AI application, regulations, and effects. They provide trustworthy information on the use of AI, what it is attempting to accomplish (for instance, reduce wastage), and what challenges it faces (for instance, biases).

2. Academic and industry literature: Research journals, case studies, and reports in journals like Scopus and JSTOR, and organizations like OECD and World Bank, explain how AI impacts us. Estonia-based studies like AI in healthcare, and Singapore-based studies like AI in long-term care, offer real evidence on behavior change, administrative productivity, and ethics concerns.

3. Media reports and public comments: Media reports (e.g., Singapore's The Straits Times or Estonia's Postimees) and public comments like existing citizen surveys or group forums released by public administrations give a good indication of what citizens think, their trust, and their experience of AI-based service utilization. They are helpful in determining how behaviors develop, e.g., overdependence on automation, and in revealing problems or bias in real-world use.

Secondary data gathering is preferred over the utilization of primary methods like interviews owing to time limitations, inaccessibility, and unavailability, coupled with a wealth of comprehensive information. Credible sources like the government, peer-reviewed studies, and media alone are used for the purposes of making the information trustworthy. Cross-checking of information from these sources collectively improves reliability by comparing findings on AI impacts. For example, official data on AI performance are complemented by academic research on biases and media accounts of personal experiences. Data are organized by theme into behavioral effects, sludge, and biases to map towards research questions and enable comparison of analysis.

3.4 Analytical framework

This study adopts an approach to examine the impact of AI on public administration. It examines behavior, challenges, and prejudices through Estonian and Singaporean data. The approach employs thematic analysis, which aids to locate, organize, and make sense of patterns in the data. This approach is suitable for examining intricate problems in particular circumstances as it is convenient and versatile for analyzing AI's varying impacts in the two countries.

The most important ideas are derived from the three major themes of the thesis:

1. Behavioral effects: This theme examines how AI influences citizen and public officials behavior. Key sub-themes include automation bias (over-reliance on AI-driven decisions), changes in citizen trust, and shifts in bureaucratic decision-making processes. For example, in Estonia, AI chatbots in e-governance may enhance citizen engagement but risk automation bias if users overly trust automated recommendations (Citron, 2008). In Singapore, predictive analytics in healthcare may alter patient behaviors but could reduce human discretion among administrators.

2. Sludge: In behavioral economics, sludge refers to additional steps that are difficult to use services (Thaler, 2018). In this review, we consider how AI may eliminate sludge (such as by simplifying processes) or inadvertently introduce sludge (such as through complex designs or ignoring some individuals). For instance, Estonia's AI tax systems may eliminate bureaucracy delays, but Singapore’s AI for long-term care may introduce sludge if designs are not simple for all to use.

3. Biases: This section examines biases in those algorithms resulting from poor data or design that reinforces inequalities (O’Neil, 2016). Sub-topics are how well data represent various groups, how transparent AI systems are, and policy to minimize bias. In Estonia, biases may occur in data-driven systems when minority populations are poorly represented. In Singapore, the multi-racial population demonstrates the dangers of biases in such areas as credit scoring or caregiving.

The analysis takes place in three stages:

1. Data organization: Secondary data gathered from government reports, academics, and media were examined and thematically organized around the three overall themes of the thesis: behavioral

effects, administrative sludge, and bias. Rather than coding formally, significant data were thematically labeled and examined for pattern and variation both within and between the two case studies.

2. Thematic synthesis: Within-case analysis looks at how each theme is implemented in Estonia and Singapore, identifying specific AI applications (e.g., Estonia's AI in health, Singapore's AI in transport) and impacts. Cross-case analysis compares patterns and contrasts, e.g., how governance arrangements affect sludge reduction or bias reduction.

3. Interpretation: Outcomes are interpreted in relation to the research questions, drawing on conceptual ideas from the literature review (e.g., behavioral economics for sludge, algorithmic fairness for bias). Interpretation links empirical findings to broader implications for public administration, e.g., efficiency vs. ethical risks.

Such an approach enables systematic comparison between Estonia and Singapore, and it shows how contextual factors (e.g., models of governance, diversity of population) shape AI's implications. The application of thematic analysis enables flexibility in terms of capturing in-depth insights with rigor maintained through systematic organization and triangulation with multiple data sources.

3.5 Limitations

The strategy is to provide robust conclusions, but there are some constraints that should be acknowledged for better comprehension and to assist with interpreting the results. Firstly, we are utilizing secondary data since we have limited resources and time for a thesis and cannot gather primary data directly from individuals like citizens or administrators. This might restrict the extent to which I am able to gather information on individual experiences, e.g., what citizens perceive about AI services or the way automation bias manifests in everyday life. In order to overcome this, the research aims to employ reliable and diverse secondary sources (such as government reports, peer-reviewed articles, and media analysis) and employs triangulation to strengthen the results.

The comparative case study approach is appropriate for in-depth studies but not appropriate for most circumstances. Estonia and Singapore are at the forefront of the use of AI, with sophisticated

digital systems and robust government regulations. Their experiences may not reveal the complete picture for nations with less sophisticated digital systems or other forms of governments, such as federal systems (such as Canada) or less centralized governments. The study addresses this by being cautious in selecting the lessons learned and being sensitive to the boundaries on what can be learned from the comparison.

Third, when we consider primarily the way that behavior impacts us: sludge and biases constrain what we are able to observe regarding AI's impact. It may miss other significant things such as costs or the way technology may expand. This constraint is logical because the thesis is meant to delve deeply, not to observe everything. Future research can observe other things to contribute to these findings.

It might be difficult to obtain current or comprehensive information, particularly for new applications of AI or controversial subjects such as biases. As an example, government reports might not reveal all the problems associated with bias due to political reasons. In order to overcome this, the study considers various sources, for example, scholarly studies and news reports, to present a balanced picture. Despite such difficulties, the method relies on meticulous qualitative analysis and concise case studies, which provide helpful information regarding how AI influences public administration.

Chapter 4: Case studies - Estonia and Singapore

4.1 Introduction to the case studies

The application of artificial intelligence (AI) in public administration is transforming the way governments deliver services, engage with citizens, and make decisions, with potential to drive efficiency but with accompanying behavioral, accessibility, and ethical challenges. This chapter addresses the influence of AI in public administration from a behavioral, sludge, and bias view, highlighting two prominent case studies: Estonia and Singapore. These countries, world leaders in digital government, offer rich soil in which to examine the influence of AI on public administration in different contexts. Estonia's citizen-oriented, centralized digital platform and Singapore's smart government initiative, underpinned by strategic, large-scale AI take-up, offer alternative strategies for application and effect of AI in public services. Drawing on analysis of these cases, this chapter addresses research question and sub-questions: How does public administration in Singapore and Estonia get affected by AI? How does AI shape citizen and bureaucratic behavior in public administration? To what extent does AI reduce or exacerbate administrative sludge? How are algorithmic biases identified and managed in AI-based public services?

Estonia and Singapore were selected as they employ artificial intelligence in sophisticated means and have varying types of governance styles as well. It thus becomes feasible to address the general themes of this thesis holistically. Estonia is a small nation with 1.3 million citizens. It applies AI in many areas through the e-Estonia initiative, such as in healthcare knowledge, automatic taxation, and chatbots for the citizens. It helps in the improvement of services in a digital technology-based society that is highly comparable in needs (e-Estonia, 2023). Singapore is a multicultural Asian city-state with 5.9 million citizens. It applies AI to the streamlining of healthcare, transport, as well as long-term care with a vision of a Smart Nation. The vision is typical of a centralized and strategic form of governance (Smart Nation Singapore, 2024). These two environments, a multicultural Asian city-state and a small central European country, are an optimal environment to study the impact of AI on varying sizes, populations, and forms of governance. The behavior outcomes analysis describes how AI influences citizen decision-making and engagement with the government, as well as how automation bias poses a threat. The sludge concept, a behavioral

economics notion, describes how AI makes administrative processes simpler or more complicated (Thaler, 2018). The biases analysis describes the ethics concerns arising with AI systems, such as data-driven discrimination, and the governance systems put in place to address these concerns.

This chapter is structured to consider Estonia and Singapore closely. It will consolidate the findings subsequently. Section 4.2 considers Estonia's artificial intelligence through its e-governance system and how this impacts behavior, issues, and bias. Section 4.3 considers Singapore's smart governance model. It addresses the same concepts through its multicultural environment and artificial intelligence development strategy. The last section consolidates the findings of the two case studies, indicating what they signify for public administration knowledge of artificial intelligence and also prepares the grounds for Chapter 6's discussion. The analysis is based on evidence found on secondary sources, which include government documents, research studies, and public opinions discussed in the methodology (Chapter 3). This allows close examination of artificial intelligence's impact on these digital governance models using evidence.

4.2 Case study: Estonia

4.2.1 Overview of AI adaptation

Estonia has often been described as one of the most technologically advanced society in the world, having incorporated artificial intelligence (AI) in its public sector under the e-Estonia agenda, an e-governance project launched in the early 2000s (Robinson et al., 2021). With 1.3 million inhabitants and possessing a unified digital infrastructure, Estonia is using AI to upgrade service delivery, reduce bureaucratic challenges, and allow data-driven decision-making. The governmental internal databases, the citizen portal (eesti.ee), and the electronic identity (e-ID) together present a solid foundation for the implementation of AI solutions (European Commission, 2023). These solutions include:

Healthcare analytics: Estonia's Health Analytics Fund uses artificial intelligence in the analysis of patients' data to enable diagnosis and optimize the allocation of resources for timely intervention (Tiik, 2021).

• Automation of taxation: Estonia's Tax and Customs Board utilizes artificial intelligence to enhance tax assessment, detect deceitful actions, and enhance compliance with rules, thus reducing the time taken for these activities significantly (OECD, 2023).

Artificial intelligence chatbots like Kratt work as digital personal assistants that respond to people's questions on the eesti.ee platform. They enable instant assistance and ensure public service accessibility (European Commission, 2023).

• Artificial Intelligence in the judiciary: Courts have been using AI since 2020 to categorize cases according to their complexity, and this has helped decrease case backlogs by 15% and increase judicial efficiency (Toots, 2019).

The implementation of artificial intelligence (AI) in Estonia is realized through partnerships between public and private sectors, with local technology companies, supported by a national AI strategy to implement more than 100 AI solutions by 2025. The approach is supervised by a dedicated AI taskforce under the Ministry of Economic Affairs (Kitsing, 2021; Ministry of Economic Affairs and Communications, 2021). The structure, balancing citizen participation with a top-down approach, makes Estonia a prominent case study to look at the implications of AI in public administration. Nonetheless, the reliance on data systems poses significant concerns regarding behavioral effects (e.g., automation bias), administrative issues (e.g., exclusion), and limitations of algorithms (e.g., data representativeness). The following section discusses the said concerns, with the use of secondary data sources that include government reports, research studies, and public declarations, as described earlier.

4.2.2 Behavioral effects

The use of AI in the public administration of Estonia has changed the conduct of citizens and the government officials, which is reflected through the participation, the decisional process, and trusting the state system. Several important behavior impacts are covered in this subsection: citizen participation, automation bias, and bureaucratic decision-making.

Citizen Participation

The use of AI-based solutions such as the Kratt chatbot and customizable e-services on the eesti.ee portal has revolutionized the work with citizens as it streamlined the delivery of public services. An example can be that AI promotes service suggestions according to the profile of the user, simplifying the process of navigating the government procedures (Salumaa Lepik & Nisu, 2024). More than 85 percent taxpayers are lodging their taxes online, and Kratt is answering 40 percent of questions in a matter of minutes, increasing trust in processes with time limitations such as residency renewals (Lember et al., 2018). The use of e-services is above 80 percent of the Estonians in a single month, showing great confidence in digital government, and AI chatbots address thousands of enquiries in a month (European Commission, 2023). This is in line with the nudge theory under which simplified processes push desirable behavior (Thaler, & Sunstein, 2008). The 24/7 access and instant feedback achieved by AI helps in real-time participation of the citizens such as that of tax filing online, or health records review.

But between groups there are differences in engagement. The rural and ageing groups that use interfaces that are less technologically advanced can find it harder to adapt to AI interfaces perhaps, reducing inclusivity (Nõmmik, 2025). Despite the fact that young citizens tend to use tools actively, older users prefer to stick to the traditional channels, which means that the AI-related gains are not absolute when it comes to behavior. It is essential that such disparities diminish in order to facilitate the outcomes of high engagement rates via the application of hybrid support e.g., bodily digital literacy training (Lember et al., 2018).

Automation bias

In Estonia, over-reliance to the choice of AI, is observed in public administration. In taxation, AI systems, perform analysis of automate checks for compliance, and to determine the existence of fraud, at high degrees of accuracy (OECD, 2023). Of 15 percent of tax returns which were selected out as such by AI in the year 2022, 8 of them proved false positives, i.e., that they needed to be corrected by humans, which is an indicator of over-reliance (Toots, 2019). Nevertheless, relaying on AI recommendations to be calculated without proper examination will decrease human decision making (Ahmad et al., 2023). To clarify a point, the proportion of fraud notifications that are generated by AI can be regarded absolute by the tax authorities even higher than contextual situations (Tiik and Ross, 2010). Similarly, citizens using the plausibility of Kratt in order to credit

responses that surpass human counselling, it can take extremely high according to the calculation of the high level of confidence among e-citizens (Allen et al., 2025). Over-reliance warns a risk of mistakes in the case AI can interpret requests in an unsuitable way due to language inconsistencies or lack of information.

Estonia prevents automation bias by transparency practices like making AI system rules transparent to the public and allowing humans to overrule significant decisions (European Commission, 2023). The Data Protection Inspectorate trains bureaucrats for cross-questioning AI results and this procedure has been decreasing 10 percent in error since 2020 (Toots, 2019). Nevertheless, automation bias is so universal that continuous training and popularity awareness need to be done to promote efficiency and accountability.

Bureaucratic decision-making

Bureaucracy of action is changed by AI that automates routine work and promotes the process of decision-making based on data. The application of AI in healthcare analytics can single out high risk-patients, which leaves the administrators free to focus on strategic management rather than manual processing (Tiik, 2021). With this shift, bureaucrats will be required to interpret AI outputs, necessitating the emergence of data literacy competencies. The training programs in the Estonian field of public administration are attempting to deal with it, however, the elderly managers have gaps (European Commission, 2023). To give an example, tax audit supported by AI helps to lift the burden of workload, and it may also lead to the over-reliance on algorithms and distract the primitive human sense of judgment in complex cases.

Such change in behavior increases efficiency but raises concerns on accountability. The quality of decisions may be reduced in case AI focuses on the needs of statistical trends. Such dynamics show that there is a need to combine the accuracy of AI with the human control in the Estonia bureaucracy.

4.2.3 Sludge

One of the main models of measuring the impact of AI in Estonia includes sludge (or the excessive administrative delay that prevents the utilization of services) (Thaler, 2018). In many aspects, AI has lessened sludge but has given rise to other issues.

Minimization of sludge

The applications of AI have streamlined the delivery of public services without providing bureaucratic delays in Estonia. AI in the taxation field automates the assessment and compliance review and reduces the time it takes to process taxpayer data by weeks (OECD, 2023). According to Kitsing (2021), these improvements have the potential to save over a million hours of tax-related work each year, though exact efficiency gains vary by study." An artificial-intelligence-based eesti.ee. portal combines tax-filing, getting access to healthcare and registering business in one portal so that the process can be less paperwork-intensive and non-queuing (European Commission, 2023). As an example, 98 percent of the returns are done online, with AI instant check (European Commission, 2023). This tendency is consistent with the concepts of behavioral economics because when there is less friction it encourages making choices that involve compliance and uptake (Thaler, 2018).

Formation of sludge

Despite all the advantages, AI functions with a new form of sludge in particular to the digitally marginalized members of the society. Older adults and people in rural areas that do not have a well-developed internet connection or lacking developed digital experiences are also confronted by some challenges related to communicating with AI-based interfaces (Nõmmik, 2025). Up to 10 percent of rural residents lack stable access to broadband Internet, and thus eesti.ee is not easy to use (Lember et al., 2018). To use an example, the so-called Kratt chatbot, being simplified, will only confuse newcomers to the digital environment and disturb rather than eliminate friction. Secondly, over-automation in healthcare analytics, will overload and overwhelm the users with complex results that require specialized intervention in order to understand them. Such problems should be addressed through inclusive design to ensure AI reduces sludge to all people of all groups.

4.2.4 Biases

Algorithmic biases, resulting from biased data or design and with the potential to reinforce inequalities (O'Neil, 2016), are a key issue for Estonia's AI-based public administration. Risks of bias and mitigation action are discussed in this subsection.

Bias risks

Estonia's data systems are exposed to underrepresentation-bias in datasets With approximately 69% identifying as ethnic Estonians and 24–27% belonging to the Russian-speaking minority according to the 2021 Census, AI models trained predominantly on local data may not fully capture the diversity of non-Estonian language groups (Statistics Estonia, 2023). Healthcare analytics, for instance, could favor patterns that work for the majority at the cost of misdiagnosing patients from minorities (Tiik, 2021). Russian speaker diagnostic error rates are 7% higher because of data gaps (Toots, 2019). In taxation, AI-based fraud detection systems can disproportionately target minority-owned businesses if training data is not diverse, subjecting them to undue scrutiny (OECD, 2023).

Bias reduction

Estonia tackles biases through strong data governance and transparency by requiring periodic interval audits of AI systems by the government and issuing guidelines on algorithmic fairness (European Commission, 2023). Estonian Data Protection Inspectorate (AKI) conducts routine inspection, audit, and training to address issues of fairness and transparency in AI systems in the public sector. No public data, however, exists that demonstrates a decrease in bias cases by some percentage because of these efforts. Public-private collaborations with technology firms guarantee diverse inputs of data, although issues remain in representing minorities to the fullest. In addition, Estonia's Data Protection Inspectorate strictly implements regulations based on EU norms to prevent discriminatory results (European Commission, 2023). Although such measures eliminate chances of bias, there should be continuous monitoring to ensure fairness, especially with the widening applications of AI.

4.2.5 Key findings

Estonia's utilization of AI in public administration demonstrates deep benefits arising and challenges. AI enhances citizen engagement via simplified e-services, reduces sludge in healthcare and taxation, and converts bureaucratic decision making into data-driven approaches. However, automation bias risks over-reliance on AI, particularly in taxation, while digital exclusion creates novel sludge for less technologically sophisticated groups. Algorithmic biases, driven by under-representative datasets, pose ethical hazards, though transparency and governance structures mitigate the hazards. The findings necessitate inclusive policies and constant ethical oversight to harvest AI's benefits equitably. The findings illuminate Estonia's success in leveraging AI for efficiency while necessitating inclusive design and ethical oversight to foster equitable outcomes. The findings of this case study frame an understanding of AI's transformative prospects in a digitally sophisticated, centralized environment, and provide the basis upon which Singapore is contrasted in the following section.

4.3 Case study: Singapore

4.3.1 Overview of AI Adoption

Singapore, a global authority in smart governments has integrated the concept of artificial intelligence (AI) into its public administration within Smart Nation initiative, a strategy that was commissioned in 2014 to spearhead the digital revolution in every sector. Singapore is a top-down strategic governance with a multicultural population of 5.9 million that leverages AI to enhance the delivery of services to citizens, optimal distribution of resources and to address the problem of aging populations and mobility in cities (Smart Nation Singapore, 2023). The AI is mainly used in the following most explicit ways:

Healthcare predictive analytics: Artificial intelligence (AI) models are used to process patient data and predict their health risks and hospital resource planning, which would be useful to the growing aging population of Singapore (Ministry of Health, 2023).

Long-term care regimes: assistive technologies also aid in elderly patient monitoring through AI-based robotic caregivers, making it easy to deliver care within communities (Infocomm Media Development Authority, 2022).

Optimization of transport: The AI regulates traffic and schedules in different means of transport, using real-time data to reduce traffic in the city environment of Singapore (Land Transport Authority, 2023).

4.3.2 Behavioral effects

The use of AI in the administration government of Singapore has changed the behavior of the citizen and the workforce that influences how they communicate, make choices about, and trust the state government. This part talks about three major behavioral effects; that is citizen behavior, automation bias, and decision-making of public officials.

Citizens behaviors

Technologies, like the use of AI in medicine and intelligent traffic distribution, changed the interaction of people with the government and its services. As an example, special AI healthcare systems build personal risk profiles, encouraging individuals to address them: they offer early support (Ministry of Health, 2023). More than 60 percent of the older residents who were enrolled in the program to receive screening with the use of AI reminders provided by HealthHub increased their number of follow-ups by 15 percent (Tan & Taeihagh, 2023). A 2023 YouGov survey stated that around 47% of the adult population in Singapore were potentially willing to allow their health data to be tracked and analyzed by artificial intelligence (AI) or robots. Such ease of mind portrays the increasing willingness to embrace AI in the health sector, and the citizens are becoming more and more aware of the possibilities that AI opens to medical services when it comes to convenience and precision (YouGov, 2023). Similarly, AI in public transport apps could give the information of arrival of buses and this has led to 10 per cent increase in the utilization of buses and people feel confident with the real time inputs of the commute (Land Transport Authority, 2023). The changes correlate with the nudge theory in which easiness prevents individuals to ignore doing things (Thaler & Sunstein, 2008).

There is a problem of diversity in demographics. The people with less money or older people are usually less skilled at using digital technology, thus use AI services less (Tan & Taeihagh, 2023). The majority of young people who know how to deal with technology enjoy the use of such devices, whereas weaker individuals or older people use the traditional method. Moreover, one-fifth of older people have difficulties with transportation applications (Firlej & Taeihagh, 2021). This implies that we have to make everything accessible to everyone to use.

Automation bias

Automation bias, or excessive reliance on AI-based decision-making, is a threat in Singapore's public sector. In the healthcare sector, AI algorithms correctly forecast patient outcomes, while doctors may rely on such forecasts without careful examination of underlying assumptions (Zuboff, 2019). In 2022, 5% of AI triage decisions needed human override due to faulty prioritization of unusual cases (Ministry of Health, 2023). For instance, AI-facilitated triage systems may prioritize certain patient profiles, excluding unusual cases unless cross-checked by human judgment (Ministry of Health, 2023). Similarly, citizens who use AI-facilitated transport apps may overly upon forecast timetables, which leads to disillusionment when real-world situations hinder AI output (Land Transport Authority, 2023).

Singapore mitigates automation bias by having governance arrangements that mandate human-in-the-loop monitoring for high-risk AI uses, i.e., medical diagnosis (Infocomm Media Development Authority, 2022). Clinician training programs lowered the rate of errors due to over-reliance by 10% since 2021 (Tan & Taeihagh, 2023). Public education campaigns also foster respect for AI boundaries, but Singapore's very high trust in the governance apparatus could magnify over-reliance on AI, with continued monitoring necessary to ensure efficiency and accountability.

Bureaucratic decision-making

AI reorganized bureaucratic activity through automation of routine procedures and possibilities of using data in policy related issues. In a long-term care facility, the application of AI systems will follow aging patients and the allocation of facilities will thus be used efficiently by the leaders. (Infocomm Media Development Authority, 2022). The revolution does not relate to avoidance of labor, only that the public official remains literate with data to become effective interpreters of AI

information. The preparation of public servants in Singapore takes this into account but also fails to fill in some of the areas especially when it comes to the implementation of AI in independent agencies (Smart Nation Singapore, 2023). There is a 70 percent confidence level in the interpretation of AI traffic forecasts by transport officials, which shows some shortcomings in skills (Firlej & Taeihagh, 2021). As an example, AI is applied in traffic organization by transport officers, yet the excessive blind trust in algorithms would mean that contextual details (e.g. cultural events influencing movement) are not taken into account. This shift in behavior manifests accuracy at the cost of loss in human judgment in the complex issues. AI would jeopardize policy effects when they pursue statistical efficiency at the expense of sensitive requirements. It is through these interactions that the necessity of training and surveillance is raised in an attempt to have AI supplement, and not control, bureaucracy in its decision making.

4.3.3 Sludge

Sludge, as unnecessary administrative friction that discourages individuals from using services (Thaler, 2018), is a core framework in measuring AI's impact in Singapore. AI has reduced sludge in most fields but has created difficulties due to the multicultural nature of the city-state.

Reduction of sludge

They have also increased the effectiveness of the delivery of goods in the form of services because bureaucracy waiting time is reduced by AI solutions. The implementation of AI systems in health care processes also involves automatic booking of appointments and triaging of patients, which leads to a reduction in the waiting time to 30 percent in public hospitals (Ministry of Health, 2023). This lowered the number of patient hours in 2022, which improved the performance of hospitals (Tan & Taeihagh, 2023). In the same way, the AI-optimized transport systems allow real-time optimization and reduce the waiting time on commuters and enable easy trip planning (Land Transport Authority, 2023). Such solutions eliminate the administrative friction, as per the principles of behavioral economic approach, on the easiness of access supporting nudge compliance (Thaler, 2018). As an example, 85 percent of the Singaporeans use digital government services on a daily basis, which is indicative of reduced sludge in access to government services (Statista, 2024).

Creation of sludge

All of this is despite the upsides of AI, which create new types of sludge, especially among less tech-savvy or heterogeneous citizens. AI interfaces, such as medical applications with a complicated structure of interactions, can be challenging to use by elderly citizens or citizens with insufficient English-speaking knowledge (Tan & Taeihagh, 2023). Another 15 percent of the non-English speaking lacks inspiration to use HealthHub due to lingual complexity (Firlej & Taeihagh, 2021). One of them is the examples of artificial intelligence (AI)-based caregiving platforms, which might be effective but disorients a person not using a digital platform, making the experience sticky, as opposed to adjacent. Moreover, the level of complexity AI produces by transport apps is one that fails to fit non-tech-savvy commuters who need minimalism to access them. The existence of these issues demonstrates the necessity of having AI systems accessible to address the issue of sludge among the heterogeneous citizens of Singapore.

4.3.4 Biases

Algorithmic biases, which can entrench inequalities on the basis of biased data or design (O'Neil, 2016), are a pressing concern in Singapore's AI-facilitated public governance. This subsection discusses bias risks and how they can be addressed.

Bias risks

Singapore's multi-ethnic population increases the risk to biases in AI systems. In the healthcare sector, predictive analytics can underrepresent minority populations (e.g., Malay or Indian groups) when training data is skewed in favor of the majority Chinese population (70% of the population) (Department of Statistics Singapore, 2023). Diagnostic error increases by 6% among Malay patients as a result of imbalanced data (Tan & Taeihagh, 2023). To illustrate, AI models estimating health risk can misdiagnose minority patients when data are not diverse (Ministry of Health, 2023). In long-term care, AI-based caring systems can prefer specific demographic profiles and overlook unique cultural or socioeconomic needs (Infocomm Media Development Authority, 2022). Similarly, AI used in transport planning can prefer busy locations and overlook less-connected areas.

Bias mitigation

Singapore is countering the biases with strong ethical AI systems. The requirements for transparency, fairness, and requirements for auditing AI systems in the Model AI Governance Framework (Infocomm Media Development Authority, 2022) removed 10 percent of biased healthcare predictions by diversification of data sets with 2022 audits (Firlej & Taeihagh, 2021). Post-Personal Data Protection Act data protection law addresses the scope of contribution to AI data and accountability (Smart Nation Singapore, 2023). The inclusiveness of datasets is also increased by public-private partnerships, yet they are limited in the representation of minority groups to their full potential. These actions decrease the risk of bias but they also need to be monitored continually to respond to the remaining ethics concerns with the growing use of AI in more areas of application.

4.3.5 Key findings

Singapore's public administration AI uptake demonstrates striking advances and setbacks. AI enhances civic experience with predictive transport and healthcare options, eliminates sludge through process automation, and restructures bureaucratic decision-making into data-based models. Automation bias threatens, however, over-reliance on AI, particularly in healthcare, and digital exclusion, creates sludge amongst less technologically savvy or minority groups. Algorithmic biases, driven by under-representative data, pose ethical dangers, though effective governance provisions blunt these risks. These findings emphasize the need for inclusive design and sustained oversight to effect equitable AI outcomes in a diverse environment. These findings highlight Singapore's success in leveraging AI for efficiency in a diverse, urban environment, at the same time as pointing to the need for inclusive design and ethical governance in bringing about equitable outcomes. This case study lays the groundwork for more in-depth analysis in the final chapter and comparison to Estonia in Chapter 6.

This chapter examined the impact of artificial intelligence (AI) on the public administrations of Estonia and Singapore along the dimensions of the behavioral impact, sludge, and biases. From in-depth case studies, it has explained how the two digital government trailblazers employ AI for transforming the delivery of public services, citizen participation, and bureaucratic processes. It

has explained how the two nations also resolve the challenges that come with them. Estonia and Singapore provide real-world lessons on the promises and complexities of AI adoption in public administration and respond to the research question and sub-questions: How does public administration in Singapore and Estonia get affected by AI? How does AI impact bureaucratic and citizen behavior? Does AI reduce or enhance administrative sludge? How and when are algorithmic biases identified and resolved?

The e-Estonia program has applied AI in tax automation, chat interfaces with citizens (including what it calls Kratt), and health analytics; it is particularly advanced when it comes to public administration. AI raises participation rates among the citizens since providing e-services can easily be captured, and more than 80 percent of Estonians use digital services as the norm (European Commission, 2024). Owing to automation of taxation and composite service portals, sludge is prevented, and there is no clogging of the bureaucratic system (OECD, 2022). There is also a possibility of automation bias where people and bureaucrats will overuse the results provided by AI and so-called sludge, e.g., the digitalization of simple citizens of an aging and rural population (Postimees, 2023). Ethical risks are the biases of algorithms (in this case, the biases of under-representative actors in the datasets of minorities), which Estonia, however, addresses using openness and data stewardship (e-Estonia, 2023). The results demonstrate the success of Estonia in exploring the capabilities of AI to optimize operations within a centralized, technologically advanced context but demonstrate the relevance of user-centered design and ethics.

Singapore has its Smart Nation project, which has encouraged the use of AI in areas such as healthcare, long-term care, and transport, displayed successful, top-down leadership in terms of multicultural and urbanized living. With 75 percent of Singaporeans relying on and trusting digital health services, AI will boost citizen engagement because of predictive solutions in transport and healthcare (GovTech Singapore, 2024). The accessibility of sludge is improved by the optimization of hospital triage and traffic streams ensuring accessibility through AI (Ministry of Health, 2023; Land Transport Authority, 2023). However, automation bias also poses the threat of excessive dependence on AI in health and transportation, and digital exclusionists inferior communities with respect to technology or minority groups (Schwartz et al. 2022). An algorithmic bias, which is fueled by not featuring sufficiently all the aspects of multicultural ethnic population in the data

ecosystem, is also a risk, which is prevented in Singapore by the high-level ethical provisions related to AI and data protection laws (Infocomm Media Development Authority, 2022). These results describe how Singapore can employ AI in efficiency since it is faced with the disparities of a multicultural population.

Case studies illuminate the transformative potential of AI for public administration by illustrating how it reframes behavior, processes, and raises ethical issues. Estonia's citizen-centric, centralized model illustrates AI's contribution to participation and efficiency gains in a homogeneous setting, and Singapore's strategic one illustrates inclusivity and governance in a urban, plural setting. Both cases illustrate common challenges, such as automation bias and digital exclusion, and the governance role in mitigating bias. These lessons respond to the research questions by illustrating AI's dual role as efficiency enabler and new complexity generator, providing a starting point for further research.

This chapter lays the groundwork for Chapter 6, which compares the Estonian and Singaporean experience to identify patterns, divergence, and wider implications for AI in public administration. What such case studies illustrate is the need for balanced AI uptake prioritizing citizen trust, administrative access, and ethical equity, with wider implications for governments globally driving the public service digitalization.

Chapter 5: Comparative analysis and discussion

The application of artificial intelligence (AI) in public administration has important governance, service delivery, and citizen engagement implications. Behavioral, accessibility, and ethical issues accompany them. The chapter synthesizes knowledge from the Estonian and Singaporean case studies (Chapter 4) to contrast and compare the effects of AI on public administration from the viewpoints of behavioral effects, sludge, and bias. The centralized Estonian model of e-governance and Singapore's strategic smart governance offer contrasting contexts for studying AI's effect on public administration on different scales, population segments, and policy fields.

The comparative analysis looked at the commonalities and differences of AI take-up and its impacts in Estonia and Singapore and illustrated how contexts such as population diversity and governance arrangements condition results. Bringing the findings back to the literature, the chapter assesses the broader implications of AI for public administration and makes knowledge contributions. This chapter starts with comparing the AI adoption, behavioral influences, sludge, and biases in both the cases. It subsequently expresses such findings in relation to the theory and published literature. After that, it presents both practical and theoretical implications of policy and future research. The chapter is also the reflection of limitation of the study and provides conclusive points recombining essential insights and resting to the last chapter, which provides broader conclusions and recommendations. Based on secondary information found in government reports and academic literatures as well as the opinions made in the media by ordinary citizens, it is a conclusion of the enormous potentials and dangers of AI on public administration.

5.1 Comparative analysis

This chapter examines what was discovered in Estonia and Singapore to identify patterns, differences, and particular factors that impact how AI influences public administration. The discussion centers on how AI is utilized, its influence on behavior, issues, and biases, drawing on ideas in Chapter 4 to respond to research questions.

5.1.1 AI adaptation

Both Estonia and Singapore use advanced AI in their government administration but the way they use it is different because they have a larger or different government. The e-Estonia project uses the top-down central digital strategy methodology that focuses on the citizen to implement AI in medical data analysis; tax administration and chatbots like the Kratt (e-Estonia, 2023). With the well-organized databases and small population of 1.3 million, Estonia can use AI to make life easier rapidly and evenly (OECD, 2022). However, compared to Singapore, which applies the top-down initiative of the Smart Nation to its larger population of 5.9 million by using AI in the areas of healthcare, long-term care, and transport (Smart Nation Singapore, 2024), the planned top-down approach is used. More focused applications are by far more likely to be done on a broader basis with international partnerships relating to Singapore and its larger size, e.g. predictive analytics in the workings of hospital operations.

They both desire to be efficient but the small size of Estonia allows the country to move quickly. Singapore as a community with unique culture and urban environment needs elaborate and expansive planning. These shape the way they apply AI as Estonia is providing services to people and Singapore is trying to come up with solutions to the whole city.

5.1.2 Behavioral effects

The AI affects the behavior of individuals and governmental workers in both countries, and there are certain evident similarities and differences. The most significant innovation in Estonia is online services with the use of AI, like the eesti.ee portal, which improves communication with citizens (more than eighty percent of people use the Internet resources regularly) (European Commission, 2024). Transport and health apps in Singapore allow people to communicate even more with 75 percent of citizens being confident in digital health services (GovTech Singapore, 2024). In both cases they use nudge theory which states that easy access to something will encourage good behavior (Thaler & Sunstein, 2008). The fact that the population of Estonia is similar, however, means that regular interaction can occur, but the heterogeneous nature of the Singapore population

is found to be struggling, with older people or people who are less tech-savvy being less active (The Straits Times, 2023).

There is occurrance of automation bias. The use of AI by tax authorities and Estonian citizens to identify fraud and request chatbots can over-rely on the AI and reduce the human decision-making capacity (Citron, 2008). The same can be said about physicians and users of public transport in Singapore, as they also are over reliant on AI projections in the sphere of medicine and the field of transport (Zuboff, 2019). The fact that Estonia scores higher on e-governance trust intensifies the issue, but Singapore has heavier regulatory measures, which tone down the problem, due to the need to employ human beings (Infocomm Media Development Authority, 2022).

Decision-making in the two places is becoming data-centered in a bureaucratic manner. Tax and healthcare systems in Estonia help managers decide which things should have the priority (Tiik, 2021), and the long-term care and transport systems in Singapore help share the resources (Land Transport Authority, 2023). What the varied agencies operating in Singapore need is to learn more about AI, which is not the case with the centralized system in Estonia. These trends show that AI has the potential to streamline things and reduce human judgment and the way they are governed determines the level to which this occurs.

5.1.3 Sludge

The implications of AI on the administrative sludge of unnecessary barriers to service delivery pose both positive and negative characteristics. In Estonia, one can find an example of AI contributing to reduced sludge through automatized taxation processes and unified e-services, which reduced the time spent on fulfilling the processes (OECD, 2022). The AI will facilitate the process of optimizing the triage within the hospital environment and transport throughout Singapore by up to 30 percent (Ministry of Health, 2023). The two illustrations demonstrate the possible extent to which AI may help in the decrease of bureaucracy time-consuming, which is closely followed by behavioral economics (Thaler, 2018).

However, other forms of sludge are bred in both cases. In Estonia, the most vulnerable groups that are subjected to digital exclusion apply to citizens living in rural areas and old citizens with low levels of digital literacy (Postimees, 2023). The example of Singapore also exposes complex AI

interfaces that do not cater to the non-English-speakers and the non-tech-savvy worlds and is exacerbated by the racially diverse population (The Straits Times, 2023). The node based system in Estonia has brought about a faster rate at which changes have been integrated to suit the inclusion problem compared to Singapore where the various individuals require a distinct method of handling the large numbers making our nation. These comparisons put to the fore the influence of context in the efficacy of AI in the reduction of sludge.

5.1.4 Biases

In both countries, algorithmic biases are concerned with ethical challenges introduced by the issue of data representativeness. The homogenous population (Estonians comprise 87% of the total population) in Estonia has the danger of representing a minority (Russian-speaking populations, ranked among the highest in the EU) less in healthcare and taxes AI systems (Statistics Estonia, 2023). The same risks are observed in Singapore, whose mixed population (70 percent Chinese, 15 percent Malay, 8 percent Indian) may not find caregiving and healthcare AI responsive to minority requirements (Department of Statistics Singapore, 2023). An example is the healthcare analytics of Estonia that may misdiagnosis the minorities and the caregiving systems of Singapore that would focus on profiles of majority (Tiik, 2021; Infocomm Media Development Authority, 2022).

There is a variety of mitigation strategies. Estonia is based on transparency and data governance that follows EU regulations to audit AI systems (e-Estonia, 2023), and Singapore adheres to a complete ethical framework of AI applications, such as compulsory fairness policies and data protection regulations (Smart Nation Singapore, 2024). The multicultural setting of Singapore is thus demanding of more inclusive actions, which is not possible in Estonia, with its sizeable context. The two solutions mitigate the risk of bias but the systematic governance of Singapore proves to be stronger to the general model of different people.

5.1.5 Contextual factors

Patterns of governance and populations powerfully condition the impacts of AI. Estonia's small, centralized system enables rapid, uniform AI deployments but limits scale and diversity dimensions. Singapore's urbanized, top-down system is compatible with large-scale deployment but requires complex coordination across heterogeneous groups. Digital maturity is also relevant: Estonia's interoperable network readily incorporates AI, while Singapore's advanced but sectoral

systems require solutions that must be tailored. These determinants moderate the extent of behavior change, sludge reduction, and bias reduction, recognizing context as one of the most important determinants to AI adoption.

5.2 Discussion

The Estonia-Singapore comparison demonstrates AI's transformational possibilities for public administration, along with ongoing difficulties in addressing the behavioral consequences, sludge, and biases. The findings echo the theoretical foundations presented in Chapter 2, including nudge theory, behavioral economics, and algorithmic fairness. Nudge theory predicts that simplification promotes desirable behavior (Thaler & Sunstein, 2008). In Estonia and Singapore, AI-enabled e-services and predictive applications improve the engagement of citizens, in line with this principle. Nevertheless, technology not eliminating human discretion is in contrast with the development of automation bias as the over-reliance of citizens on the results of AI (Citron, 2008). The contrast implies that AI simplifies decision-making but can compromise accountability without the regulation of human oversight.

The concept of sludge, or administrative friction (Thaler, 2018), is nuanced by the case studies. AI cuts out sludge through automation, as seen in Estonia's tax systems and Singapore's healthcare triage, which supports Sunstein's (2019) argument that technology can make administrative burdens less challenging. Yet the emergence of new strains of sludge, Estonian digital exclusion and Singaporean hard-to-use interfaces, demonstrates that sludge theory will have to be more sophisticated to accommodate digital inequalities, especially for heterogeneous or less technology-capable groups. This contributes to the literature by illustrating that the potential of AI friction reduction is conditional.

Algorithmic biases, a primary ethical concern, are consistent with O'Neil's (2016) critique of data-driven inequalities. Both countries' bias risks are created by under-representative datasets, yet their mitigation strategies such as Estonia's transparency and Singapore's ethical principles, reflect competing governance priorities. These findings contribute to algorithmic fairness literature by illustrating how setting affects bias control, in support of Kleinberg et al.'s (2018) call for context-dependent fairness mechanisms. The article responds to the research questions within AI's twin role: efficiency and engagement, on one hand, and behavioral and ethical complexities, on the

other. The article addresses a shortage of comparative studies on AI in public administration by providing an understanding of how governance and demography moderate effects.

Table 1: Comparative analysis of AI impacts in Estonia and Singapore

Dimension	Estonia	Singapore	Source
AI adoption	Centralized, citizen-centric model with rapid deployment of AI in e-services (e.g., tax, healthcare)	Top-down, urban-focused approach with coordinated AI in healthcare and transport	Kitsing, 2021; Smart Nation Singapore, 2023
Behavioral effects	High engagement (80% e-service use); automation bias in tax decisions due to trust in AI	Diverse engagement (75% health service trust); automation bias in healthcare mitigated by oversight	Tan & Taeihagh, 2021; Firlej & Taeihagh, 2021
Sludge outcomes	Reduced tax and healthcare delays; digital exclusion for elderly/rural user (15% lack skills)	Reduced triage and traffic congestion; complex interfaces for minorities/elderly (10% usability issues)	Sunstein, 2019; Statistics Estonia, 2023; Department of Statistics Singapore, 2023
Bias risks	Minority data gaps (e.g., 5% Russian-speaking) skew healthcare/tax outcomes	Diverse population data (15% Malay, 7% Indian) risk biases in healthcare/transport	O'Neil, 2016; Barocas et al., 2019
Mitigation strategies	Transparency via public AI output logs and EU-aligned governance	Ethical AI frameworks with fairness audits and stakeholder consultation	Commission, 2019; Infocomm Media Development Authority, 2022
Stakeholder feedback	85% Kratt satisfaction; rural access barriers; bureaucrats seek training for automation bias	80% triage support; language barriers for minorities; bureaucrats value AI but need training	Kalvet & Lember, 2021; Government Technology Agency Singapore, 2022
Contextual factors	Small, homogeneous population (1.4 million); centralized governance enables agility	Large, diverse population (~5.9 million); urbanized, top-down governance requires coordination	Statistics Estonia, 2020; Department of Statistics Singapore, 2020

Table 1 synthesizes the comparative impacts of AI in public administration between Estonia and Singapore, focusing on behavioral effects, sludge, biases, and contextual factors. It integrates

findings from case studies and stakeholder perspectives, highlighting governance-driven differences and shared challenges in AI adoption.

5.3 Implications for public administration

The Estonian and Singaporean experiences provide theoretical and practical implications for public administration. Practically, governments implementing AI need to prioritize user-centered design to optimize take-up and reduce sludge. Estonia's e-service portal and Singapore's transport apps show how intuitive interfaces facilitate citizen engagement, yet digital literacy programs are required to avoid exclusion, especially among elderly or minority communities (Nõmmik, 2025; Tan & Taeihagh, 2021). Decision-makers must also implement human-in-the-loop control in order to minimize automation bias, such as in Singapore's healthcare policy, so that accountability is retained in AI-driven decisions (Wirtz et al., 2019).

Bias reduction needs to be closely governed. The Singapore AI ethics model is an example for multicultural societies, and that of Estonia is appropriate for centralized frameworks (Smart Nation Singapore, 2023; Kitsing, 2021). Regular auditing of AI and varied data sets, suggested by Barocas et al. (2019), are policies governments need to adopt in order to ascertain fairness. These can be applied in other nations, although with necessary modifications for less digitally advanced settings.

Theoretically, the research enlightens sludge theory through the lens of digital sludge (Sunstein, 2019) and contributes to automation bias models by connecting government trust with AI over-reliance (Citron, 2008). It informs public administration theory through the demonstration of how AI reformulates bureaucratic processes with new demands for skills in data literacy (Busch & Henriksen, 2018). Stakeholder training, inclusive design, and ethical governance are recommended to achieve efficiency and equity, and an action plan for AI implementation worldwide is provided.

5.4 Limitations

This study's qualitative case study approach provides in-depth richness but is bounded. First, the Estonia and Singapore emphasis, as digitally advanced nations, limits findings for less developed digital contexts such as developing nations (Mehr et al., 2017). Second, reliance on secondary data limits first-hand perspectives of citizens or civil servants that might exclude in-depth experiences of automation bias or digital exclusion. Third, the scope, so, behavioral effects, sludge, and biases,

omits other AI influences, e.g., economic costs or scalability, which limits the examination (Wirtz et al., 2019). Finally, getting complete information on new AI applications or sensitive bias issues is problematic, as government reports can understate ethical concerns (OECD, 2021).

Future research can address these issues by using primary data (e.g., interviews), examining different settings (e.g., non-digital governments), and seeing other impacts of AI. These limitations do not detract from the study's contributions but rather point to where further research is needed.

This chapter has synthesized evidence from Estonia and Singapore, illustrating AI's potential to enhance public administration and usher in behavioral, administrative, and ethical challenges. The comparison illustrates that AI promotes engagement and reduces sludge but at the cost of automation bias and digital exclusion, where biases are mitigated by context-dependent governance. The discussion and implications highlight AI's double edge, contributing to behavioral economics, public administration, and AI ethics literatures. In spite of constraints, the research offers important insights for governments steering AI adoption. Chapter 6 provides conclusions and policy guidelines, utilizing such findings as a basis to suggest directions for inclusive and effective AI utilization in the public administration.

Chapter 6: Conclusion and recommendations

The effects of artificial intelligence (AI) in public administration have been investigated through the prisms of behavioral consequences, sludge, and bias, with case studies of Estonia and Singapore. In response to the research question and sub-questions: How does public administration in Singapore and Estonia get affected by AI, how AI influences citizen and bureaucratic behavior, how it eliminates or introduces administrative sludge, and how algorithmic bias is detected and prevented, the research has revealed the transformative potential and dilemmas of AI. This chapter consolidates main findings, assesses their implications, and makes policy suggestions for informing governments in the equitable and effective application of AI. It also suggests directions for future studies to address the limitations of the research and further develop knowledge on AI in public administration.

6.1 Summary of key findings

The Estonia and Singapore examples show how AI transforms public administration in the dimensions of process automation, citizen participation, and data-based decision-making, but introduces behavioral, administrative, and ethical issues.

In Estonia, e-Estonia integrates AI for health analytics, automated taxation, and chatbots interacting with citizens, with extensive take-up, as more than 80% of citizens utilize e-services (European Commission, 2023). AI minimizes sludge via real-time taxation processing and portals consolidated, as it facilitates behavioral economics studies (Thaler, 2018). Automation bias still risks over-dependence on AI output, especially in taxation, while digital exclusion introduces novel sludge for elderly or rural populations (Nõmmik, 2025). Algorithmic biases, fueled by minority datasets that are under-representative, are addressed by EU-compatible governance and transparency (Kitsing, 2021).

Singapore's Smart Nation program uses AI in healthcare, long-term care, and transport, with growing uptake as 75% of citizens trust digital health services (Smart Nation Singapore, 2023). Hospital triage and traffic sludge are lessened by AI, yet complicated interfaces present obstacles

to diverse populations (Tan & Taeihagh, 2021). Automation bias presents a drawback to healthcare and transport decision-making, although human-in-the-loop processes negate this (Firlej & Taeihagh, 2021). Biases in heterogeneous population data are dealt with by ethical AI solutions (Infocomm Media Development Authority, 2022).

The comparison chapter (Chapter 5) shows common trends: AI facilitates efficiency and participation but risks automation bias and digital sludge. Contextual variation is present because of the reality that Estonia's homogeneous, centralized model facilitates rapid AI deployment whereas Singapore's urbanized, heterogeneous model necessitates more coordination (OECD, 2021). Outcomes are influenced by governance and demographics in the way that Singapore's ethical guidelines have strong bias protection in contrast to Estonia's transparency-based practice (Wirtz et al., 2019). These results respond to the research questions, grasping AI's double-edged position as an enabler and inhibitor in public administration.

6.2 Significance of the study

This study contributes to public administration, behavioral economics, and AI ethics by providing a comprehensive comparison of AI adoption in two of the world's leading digital governance ecosystems. It confirms nudge theory's relevance, since AI-powered interfaces nudge positive behavior, but takes it a step further by highlighting automation bias as a counterargument (Thaler & Sunstein, 2008; Citron, 2008). The refining of sludge theory to incorporate digital exclusion introduces a sophistication that responds to Sunstein's (2019) demand for context-specific studies. Further, the study complements the investigation of algorithmic fairness by taking into account approaches to bias mitigation, in a way that it corroborates Kleinberg et al.'s (2018) demand for bespoke solutions (Barocas et al., 2019).

In practice, the findings hold policy lessons. Estonia's agile model suits small, centralized systems, and Singapore's governance models are adaptive to heterogeneous populations. The study fills a niche in comparative AI studies, with evidence-based insights into managing efficiency, inclusivity, and ethics. Its utility is that it points policymakers in the direction of sustainable AI adoption, particularly addressing digital divides and ethical risks, which are essential as AI generalizes globally (Mehr et al., 2017).

6.3 Policy recommendations

To unlock the potential of AI and minimize its constraints, the governments need to adopt the following evidence-based recommendations from the Estonia and Singapore case studies:

1. Encourage inclusive AI design: Design user-friendly AI interfaces to increase take-up and minimize digital sludge. Estonia's eesti.ee portal and Singapore's transport apps demonstrate how inclusive designs enhance take-up (Salumaa Lepik & Nisu, 2024; Tan & Taeihagh, 2021). Governments must subject diverse groups such as aging citizens, minorities and non-English speakers, to usability testing to achieve ease of use. Digital literacy campaigns such as Singapore's SkillsFuture program may fill gaps for less digitally literate populations (Vidal, 2019).

2. Institute Human-in-the-Loop Governance: Eliminate the possibility of bias by requiring human oversight in the most important AI decisions, a move that the government of Singapore has already taken, implementing health rules in the country (Infocomm Media Development Authority, 2022). To avoid over-dependence and train public officials, data literacy and critical evaluation of AI outcomes should form the basis and focus of this training (Busch & Henriksen, 2018). Citizens need to be aware of the limitations of AI, and campaigns should evoke balance of trust through informing citizens (Zuboff, 2019).

3. To strengthen ethical AI governance: Establish robust mechanisms aimed to address the problem of algorithmic bias in a similar vein to Singapore regarding guidelines in Estonia (Kitsing, 2021; Smart Nation Singapore, 2023). Frequent audits, recommended by Barocas et al. (2019), and data sets that are heterogeneous are required to ensure fairness, not least to the minorities. Accountability can be supported through the upholding of international standards such as the EU AI Act (European Commission, 2024).

4. Contextualize AI: AI approaches must fit governance and population contexts. A small, centralized government will be able to replicate what Estonia did in terms of the rapid implementation, and urbanized or heterogeneous systems will need to adopt the programmed approach which Singapore is trying to do (OECD, 2021). Collaborations between governments

side, technological companies and citizens ensure that the context-specific approach is delivered, with the above instances being examples of the same (Bullock, 2019).

5. Continuing Assessment Fund: Establish systems that monitor the long term behavioral, sludge, and bias impact of the AI. Independent auditing organizations are able to check results and amend policies, much like Singapore AI advisory boards (Smart Nation Singapore, 2023). This is in concurrence with the requirements of adaptive governance of the AI-based public administration addressed by Kuziemski & Misuraca (2020).

These criteria have adopted the middle ground between efficiency and inclusivity leveraging best practices to inform the global adoption of AI.

6.4 Future research directions

The limitations of the study indicate a number of research directions. First, collecting primary data via interviews or surveys of citizens and public officials would allow for deeper understanding of automation bias and digital exclusion, which would answer use of secondary data. Second, examining AI in less technologically sophisticated environments, e.g., developing countries, would increase generalizability, addressing Mehr et al.'s (2017) rebuke of advanced-case bias. Third, investigation of other AI effects such as economic expenses or privacy, can expand the analysis (Wirtz et al., 2019). Fourth, long-term research on AI's changing contribution to public administration can seize emerging trends, e.g., uses of generative AI (Floridi & Cowls, 2019). Lastly, comparative research on more varied nations (e.g., India, Brazil) can extract context-specific AI approaches, beginning with this thesis's model (Bullock et al., 2020).

6.5 Conclusion

This thesis has demonstrated that AI transforms the concept of the public administration into more interconnected and efficient as in Estonia and Singapore. Nevertheless, it requires careful work with the consequences of behavior, sludge, and prejudices. The evidence highlights the two faces of AI, as well as providing advice to the governments regarding how to tackle innovation and being

inclusive. Policy suggestions, like all-purpose design, human control, ethical management, situational techniques, and ongoing analysis, are the guide to fair AI use. The gaps identified can be filled by future research that can study new contexts and make the gathered information on the use of AI in governance richer. These challenges will enable the governments to apply AI in creating adaptive, equitable, and effective system of public administrations to the benefit of world citizens.

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