

Master's thesis

Degree Programme of Master of Sciences in Information Technology

March 2021

Henri Memonen

AUTOMATED RECOGNITION OF CORRUPTION INDICATORS IN PUBLIC PROCUREMENT

TURKU AMK 
TURKU UNIVERSITY OF
APPLIED SCIENCES

MASTER'S THESIS | ABSTRACT

TURKU UNIVERSITY OF APPLIED SCIENCES

Software Engineering and ICT

2021 | 64 pages

Henri Memonen

AUTOMATED RECOGNITION OF CORRUPTION INDICATORS IN PUBLIC PROCUREMENT

This thesis investigates institutional corruption in the public procurement process and proposes hypothesis models for automated recognition of corrupted procurement indicators. Combination of literature review and PESTEL strategic analysis tool was applied as research methodology. Within two years of research, several questions were placed to different government organizations for gaining an overall picture of the problem, which after most relevant questions were selected for qualitative analysis. During the research, the most problematic issue was availability of data and research structure was changed several times during the process. Outcome of the research was establishing a hypothesis model for applying automated algorithms for flagging corruption indicators within procurement data. Model was not tested, as all data provided by the target institution was incomplete. Data handled in this research was limited to data and answers provided by the target institute.

KEYWORDS:

Finnish transportation infrastructure agency, public, procurement, automated recognition, corruption, algorithms, automation, surveillance.

OPINNÄYTETYÖ YAMK | TIIVISTELMÄ

TURUN AMMATTIKORKEAKOULU

Ohjelmistotekniikka ja ICT

2021 | 64 pages

Henri Memonen

KORRUPTIOINDIKAATTOREIDEN AUTOMAATTINEN TUNNISTAMINEN ALGORITMIEN AVULLA

Tämä tutkielma tutkii institutionaalista korruptiota julkisissa hankinnoissa ja ehdottaa hypoteesimalleja korruptoituneiden hankintaindikaattorien automaattiseen tunnistamiseen. Tutkimusmetodologiana käytettiin kirjallisuuskatsauksen ja PESTEL-strategisen analyysin yhdistelmää. Kahden vuoden tutkimuksen aikana eri hallinto-organisaatioille esitettiin useita kysymyksiä ongelman kokonaiskuvan aikaansaamiseksi. Tutkimuksen aikana suurimmaksi ongelmana ilmeni validien oli tietojen saatavuus ja tutkimuksen rakennetta muutettiin useita kertoja prosessin aikana. Tutkimuksen tuloksena luotiin hypoteesimalli korruptiomittareiden tunnistamiseksi automatisoitujen algoritmien avulla. Mallia ei testattu, koska kaikki kohdelaitoksen toimittamat tiedot olivat puutteellisia. Tässä tutkimuksessa käsitelty data rajoittui kohde-instituutin toimittamiin tietoihin ja vastauksiin.

AVAINSANAT:

Väylävirasto, julkinen hankinta, automaattinen tunnistus, korruptio, algoritmit, automaatio, valvonta.

CONTENTS

GLOSSARY	5
1. FOREWORD	7
2. INTRODUCTION	9
2.1 Research topic / phenomenon	9
2.2 Structure of the thesis	10
2.3 Research questions	11
3. THEORETICAL FRAMEWORK	12
3.1 Literature review divided according to PESTEL categorizing model.	12
4. METHODOLOGY	13
4.1 Methodological approach	14
4.2 Data acquisition methods	15
4.3 Analysis methods	25
5. RESEARCH RESULTS	25
5.1 Legislation bases	26
5.2 Agency strategy bases	28
5.3 Agency code of conduct bases	29
5.4 Agency's operation philosophy	31
5.5 Agency's ICT infrastructure	33
5.6 Answers to research questions	41
6. DISCUSSION	60
6.1 Discussion of results	60
6.2 Contribution to previous research	61
6.3 Practical conclusions	61
6.4 Critical evaluation of the research design and implementation	62
REFERENCES	63

DIAGRAMS

Diagram 1. Morally corrupt tenderer flow-chart	48
--	----

PICTURES

Picture 1. Content illustration of PESTEL categories. [7]	13
Picture 2. Illustration of Finnish Transportation Agency's key figure[12]	33

CHARTS

Chart 1. Illustration chart for institutional corruption risk indicators within the public purchasing process. [2]	42
--	----

TABLES

Table 1. Illustration of difference between individual and institutional corruption.	10
Table 2. List of relevant literature reviewed during the research.	13
Table 3. List of Agency's ICT systems	34

GLOSSARY

TurkuAMK	Turku University of Applied Sciences
cr	credit
Deductive	A form of reasoning derives conclusions beginning with abstract concepts and working toward concrete evidence in order to test assumptions. [1]
Inductive	A form of reasoning that includes conclusion beginning from concrete observation and working toward the more abstract concept. [1]
Qualitative	Research design that relies on quality of description, rather than quantity, relying on rich, descriptive detail in the human process. [1]
Research design	The modes of observations that allow scientists to collect observations in systematic and structured ways. [1]
Quantitative	Research designs that rely primarily on describing on measuring phenomena in quantity, generally thought of numerical quantity. [1]
Tenderer	One who tenders contracts during a public procurement process.
Corruption	Form of dishonesty by person in position of trust and/or authority. [2]
Individual corruption	Decision makers basing their decision excluding principles of common good and receiving bribes personally. [2]
Institutional corruption	Decision makers basing their decision excluding principle of common good and receiving counter gifts via institutional channels. [2]
PESTEL	Strategic macro-environment analysis framework.

1. FOREWORD

Author has worked with several public procurement organizations in the past and seen indications in the implementation of institutional corruption public procurement operations. Author's hypothesis is that there is a significant problem of institutional corruption in Finnish society. Author has recognised current change in the environment towards more open and fair public procurement, as procurement data is becoming increasingly available. Thus, the author has recognized strong objections to releasing the data and enacting efficient legislation for termination of corrupted procurement methods.

Author has noticed that the central organisation of Finnish trade unions (SAK), confederation of Finnish industries (EK) and government officials have tight relationships and common interest in lobbying public procurement laws. SAK has strong ties to one of the major Finnish parties called (Social Democratic Party) and EK has strong ties with another major party (National Coalition Party). In addition to these two parties, the historically strong Center Party, which has been seen as being representative of rural areas and the farming industry. These three parties have had strong handholds on political nominations of government officials. In the author's opinion, even if Finland is seen as one of the most uncorrupted countries in the world, institutional corruption is strongly rooted in the society. Foundation of this structural corruption was laid during the time of Finland's only dictator president Kekkonen, as part of the mechanism was establishing a strong central government that was mainly led in cooperation by Labour Unions, corporate top managers and government officials.

In addition to increasing data availability, the author has observed that part of change in global political environment is also occurring in Finland and rise of Green Party and Finns Party poses possibilities on making needed changes in legislation, by putting pressure on old parties for setting efficient methods for surveillance and control of institutional corruption. Thus, the author does not see this to be automation and public pressure is the bottom line if any changes in to the current environment will be implemented.

Author gives special thanks to almost every person he has met working as government organisation officials, state owned enterprises management, corporate management, politician for the motivation to work on this subject. As their openly accepting attitude

toward institutional corruption has and is strongly motivating the author on pushing forward on the subject, even though it has posed significant harm to the author's business and career possibilities.

In addition, the author gives special thanks to good friend Kalle Koskinen for sparring on data analysis models, process flow determination and mathematical models presented in this thesis. In addition, the greatest thanks and respect is directed to another good friend and an especially good man Juha Nurmi, who's sharing of most of the points of views and deeper understanding of the world and mechanisms have provided the author needed reflection on the subject.

And last, but not least, the author gives his thanks to Turku University of Applied Sciences for enabling finalising the research after Tampere University of Applied Sciences did not continue the authors study rights because of prolonged research time. And specifically to Jarkko Paavola who acted as thesis supervisor.

2. INTRODUCTION

Institutional corruption in public procurement is a recognized problem in Finnish society. [2] As an example case of institutional corruption, Helsinki University Hospital procurement processes was investigated by state owned news instituted YLE and there are indications of continuing institutional corruption since the 90's. [3] This thesis investigates and proposes methodologies for applying algorithms to support recognition of corrupted procurement methodologies.

Target of the research was set to Finnish Transportation Infrastructure Agency and institutes that have legislative rights and responsibilities for supervision and/or inspection of Finnish Transportation Infrastructure Agency's operations.

Main obstacle to testing potential algorithms is the lack of availability of quantitative procurement data despite the legal regulations of transparency. [4] Thus, the analyses for detection of corruption presented on this Thesis could not be verified with real datasets. Access to data on these systems is restricted by setting high cost on delivery of data and requirement of accurate determination of requested dataset.

ICT-systems are often procured by monolith procurement method, instead of modular open source solutions in government ICT systems. When applying a monolith procurement method usually vendor lock-in is created and strong market restrictions are set to government procurements. Naturally, these vendor lock-ins cause decreased competition and restricts market competition. Lower level of modularity procurement would provide possibility for smaller enterprises to have access to the markets and data. [5]

2.1. Research topic / phenomenon

Corruption is determined to be misuse of power and influence for a person's own benefit either by illegal or unethical actions. Corruption can be divided into individual and institutional corruption, differentiation of these two different kinds of corruption is illustrated in the chart below. [2]

Table 1. Illustration of difference between individual and institutional corruption. [2]

Features of individual and institutional corruption	
Individual corruption	Institutional corruption
individuals as actors	both individuals and institutions as actors
personal, individual	community, organization, political
promotion of a private interest (advantage or benefit to the holder of the public task)	circumstances in which there is a general tendency to promote private interests in the holder of a public task
corrupt dependence relates on the individual	corrupt dependence relates on the functioning of institutions
corruption is explained through the behavior (misconduct) of individuals	organizational culture, management and operating practices become corrupt
metaphor: rotten apples	metaphor: rotten basket

Main difference between individual and institutional corruption is the role of the individual as an actor: is he acting alone or as a part of the institution in corrupted acts.

2.2. Structure of the thesis

Analysis is divided in two stages;

1) Literature review according to the PESTEL categorizing model. Goal was to recognize qualitative research questions with systematic literature review for recognition of relevant research questions for quantitative analysis.

2) Building hypothesis models for recognition of indications of corruptions in public tendering.

Research is conducted as literature review on Finnish Transportation Infrastructure Agencies official documents.

2.3. Research questions:

1. What is institutional corruption?
2. How can institutional corruption be recognized efficiently?

The preliminary research questions were divided according to the categorizing model PESTEL.

Questions for literature review were set as follows:

- Political: What are political goals set for the target organisation (legislation)?
- Economical: What are the economical incentives for stakeholders?
- Social: Does corruption affect public procurement?
- Technological: Is there a quantitative method to use algorithms for recognition of corruption?
- Environmental: What environmental requirements are related to public procurements in the target organisation?
- Legal: How does the legislation affect the actions of operatives?

Research question for methodology establishment was set as follows:

- How can corruption indicators be recognized with automatic algorithms?

3. THEORETICAL FRAMEWORK

PESTEL analysis is a macro-environmental strategic analysis framework for political, economical, socio-cultural, technical analysis, legal and environmental factors. [6] Illustration of content of each category can be found in the picture below.

Research is conducted as literature review on Finnish Transportation Infrastructure Agencies official documents.

3.1. Literature review divided according to PESTEL categorizing model.

PESTEL analysis tool is being used for categorizing macro-environmental factors in the operational environment. Pestel analysis is divided to six different sectors of evaluation, which are political, economic, social, technological, environmental and legal. [7]

Political factors in the PESTEL model includes government intervention in certain industries, which includes policies of government, foreign trade and taxation. Political stability, corruption, labor laws, environmental laws, trade restrictions, nation's education systems, infrastructure and health regulation. [7]

Economic factors in the PESTEL model determine certain economic indicators, which includes rates of economic growth, inflation, interests, unemployment and consumer purchase power and supply demand model analysis. [7]

Social factors in the PESTEL model are presenting social demographic characteristics, such as norms, customs, values in the target populations demographics. These characteristics are usually measured with indicators such as population growth, age- and income distributions, safety emphasis, career- and lifestyle attitudes and cultural barriers. [7]

Technological factors in the PESTEL model are innovations that are changing operational models in certain industries. These factors include level of innovation in the target market, incentives provided for innovations, research and development activities within the market. [7]

Environmental factors in the PESTEL model are ecological and environmental characteristics such as weather and climates, specifically changes within these factors. These factors include effects on tourism, agriculture on public relations. [7]

Legal factors in the PESTEL model are already being evaluated on the Politic part of PESTEL analysis on a more overall level. Legal part of PESTEL analysis covers more specific factors on legislation within the target market, such as discrimination-, employment-, consumer-, copyright-, patent-, health and safety laws. [7]

P	E	S	T	E	L
Government policy	Economic growth	Population growth rate	Technology incentives	Weather	Discrimination laws
Political stability	Exchange rates	Age distribution	Level of innovation	Climate	Antitrust laws
Corruption	Interest rates	Career attitudes	Automation	Environmental policies	Employment laws
Foreign trade policy	Inflation rates	Safety emphasis	R&D activity	Climate change	Consumer protection laws
Tax policy	Disposable income	Health consciousness	Technological change	Pressures from NGO's	Copyright and patent laws
Labour law	Unemployment rates	Lifestyle attitudes	Technological awareness		Health and safety laws
Trade restrictions		Cultural barriers			

Figure 1. Content illustration of PESTEL categories. [7]

4. METHODOLOGY

4.1. Methodological approach

Analysis is divided in two stages;

- 1) Literature review according to the PESTEL categorizing model. Goal was to recognize qualitative research questions with systematic literature review for recognition of relevant research questions for quantitative analysis. [7]
- 2) Building hypothesis models for recognition of indications of corruptions in public tendering.

Research is conducted as literature review on Finnish Transportation Infrastructure Agencies official documents.

Objectives of the research were set as follows:

1. Understand relevant corruption indicators from public procurement data
2. Gain sufficient amount of procurement data from the target institution
3. Analyze information gained from the literature review
 - 3.1. Gain information on recognized problems in public procurement
 - 3.2. Determinate relevant corruption indicators
4. Analyze data gained from the literature review
 - 4.1. Determinate relevant problems in procurement
 - 4.2. Build a hypothesis on how problem indicators could be recognized automatically with software algorithms.

Scope of the material used on this research was limited to government official documentation publicly available and provided based on information requests sent to institute officials.

4.2. Data acquisition methods

Research is conducted as literature review of government official documents. Documents were acquired from publicly available sources and information requests to government officials.

In the beginning of the research, contacts with Finnish Transportation Agency were made directly with specific officials. These officials rarely provided answers and quality data. After utilising methodology for information requests where contact was made to the official registry (kirjaamo@vayla.fi), answers were given by more professional personnel. Validity of provided procurement information was low and relevant information was missing from provided datasets, which made it impossible to validate hypotheses in this thesis. Finnish Transportation Agency also referred to tutkihankintoja.fi -service, which after more careful investigation showed that data provided to the service from Finnish Transportation Agency is incomplete and service provider (HANSEL) did not have direct access to all procurement data possessed by government institutes.

Table 2. list of relevant literature reviewed during the research.

Data	File format	File Date	File name
Tilintarkastajan väliraportti Liikenneviraston hankintamenettelyiden laillisuus- ja asianmukaisuustarkastuksesta	PDF	12.02.2019	456_LiVi_vr_hankinnat_2018_JOK_MLT.pdf
Tilintarkastajan vuosiyhteenveto	PDF	30.04.2019	456_LiVi_vyv_2018.pdf
Tilintarkastajan väliraportti Väyläviraston hankintojen laillisuus- ja asianmukaisuustarkastuksesta	PDF	03.01.2020	4560_vayla_vr_hankinnat_2019.pdf
Tilintarkastajan vuosiyhteenveto	PDF	28.04.2020	4560_vayla_vyv_2019.pdf
Liikennevirasto / Finnish Transport Agency	PDF	-	Appendix 3 Pricing - Liite 3 Hinnat.pdf
Regulation	PDF	16.11.2011	Appendix 6.i - Preparatory phase plan.pdf
Radantarkastuspalvelut - Track inspection services Yhteyshenkilöt / Contact persons	PDF	-	Appendix 9 Contract Persons - Liite 9 Yhteyshenkilöt.pdf
Hallituksen esitys eduskunnalle laiksi Liikenne- ja viestintäviraston perustamisesta, Liikennevirastosta annetun lain muuttamisesta ja eräksi niihin	PDF	-	asiakirja_258189.pdf

liittyviksi laeiksi			
Selvitys rautateiden tavaraliikenteen kilpailun edellytyksistä	PDF	24.05.2018	asiakirja_271370.pdf
Getting started with BIM for building design	PDF	-	autodesk-ebook-bim-getting-started-guide-bldgs-en.pdf
Euroopan parlamentin ja neuvoston direktiivi 2012/34/EU	PDF	14.12.2012	CELEX%3A32012L0034%3AFI%3ATXT.pdf
Civil engineering benefits of BIM	PDF	-	civil-engineering-ebook-benefits-of-bim-en.pdf
Code of conduct	PDF	04.01.2021	Code of conduct - Väylä.pdf
Euroopan parlamentin ja neuvoston asetus (EU) N:o 1315/2013	PDF	20.12.2013	DOC_1.pdf
Esteellisyysäännöksiä koskeva ohje Väyläviraston henkilöstölle	PDF	02.09.2019	Esteellisyysäännöksiä koskeva ohje Väyläviraston henkilöstölle_lopullinen-1.pdf
Hankintakategoriaraportti - Sopimus	xlsx	02.01.2009	Hankintakategoriaraportti_digitalisaatio.xlsx
Hankintatoimen kehittämishankkeen loppuraportti: Tulokset sekä toimenpide- ja kehittämisehdotukset	PDF	06/2016	Hankintatoimen kehittämishankkeen loppuraportti 6_2016.pdf
Hankintatutka 2020 -kyselyn tulokset	PDF	22.09.2020	Hankintatutka_2020.pdf
Digitaalinen tieto, innovatiiviset palvelut, hyvät yhteydet Liikenne- ja viestintäministeriön hallinnonalan konsernistrategia 2016–2020	PDF	01/2016	Henri_1_2048px_bw.pdf
Rakenteellinen korruptio	PDF	04/2015	Korruptio Suomessa - Vaasan yliopisto.pdf
Järjestelmäkuvaukset väylä	xlsx	-	järjestelmäkuvaukset_väylä.xlsx
LIITE 1: Palvelun tuottamista koskevat vaatimukset	PDF	-	Liite 1 Palvelun tuottamista koskevat vaatimukset.pdf
LIIKENNEVIRASTO - Radantarkastuspalvelut liite 2 Valmisteluvaiheen vaatimukset	PDF	-	Liite 2 Valmisteluvaiheen vaatimukset.pdf
Liikenneviraston tietoaineistojen käsittelyohje yhteistyökumppaneille	PDF	24.03.2015	Liite 4 Tietoaineistojen käsittelyohje.pdf
Tulosopimuksen mukaiset tavoitteet 2016	PDF	2016	Livi_osavuosisiraportointi_2016.pdf
Tulosneuvottelut, syksy 2017	PDF	2017	Livi_osavuosisiraportointi_2017.pdf
Tulosneuvottelut 2018	PDF	2018	Livi_Osavuosisiraportointi_2018.pdf
Liikenneviraston tutkimuksia ja selvityksiä	PDF	2018	Its_2018-37_rataverkon_kokonai

Rataverkon kokonaiskuva			skuva_web.pdf
Liikenne- ja viestintäministeriön talousarvioehdotus	PDF	2018	LVM TAE 2018 10.8.2017.pdf
TAE 2019 LVM ehdotus	PDF	-	LVM TAE 2019 vertailu.pdf
Talousarvioesitys 2019, Ministeriön ehdotus	PDF	09.08.2018	LVM TAE 2019, 9.8.2018 .pdf
Miika Mäkitalo Market Entry and the Change in Rail Transport Market when Domestic Freight Transport Opens to Competition in Finland	PDF	2007	makitalo.pdf
Väylävirasto Osavuosisraportointi syksy 2019	xlsx	2019	Osavuosisraportointi_syksy_2019_Väylä.XLSX
Uusi radantarkastuspalvelu ja tietojen hyödyntäminen Tuomo Viitala, Pikkurata	PDF	15.03.2017	Pikkurata.pptx.pdf
Väyläviraston voimassa olevat puitejärjestelyt	xlsx	16.05.2019	Puitejärjestelyt_Vayla.xlsx
Puitesopimusten toteumat tilauksittain	xlsx	2018, 2019	Puitesopimusten toteumat tilauksittain_2018_2019.xlsx
Puitesopimusten toteumat tilauksittain	xlsx	2019	Puitesopimusten toteumat tilauksittain_2019.xlsx
Valtion rataverkko	PDF	01.01.2018	Rataverkko2018_web.pdf
Sopimusmuutos sopimukseen Radantarkastuspalvelut	PDF	30.09.2016	Sopimus optioista.pdf
Sopimus Liikennevirasto Radantarkastus	PDF	24.05.2016	Sopimus VT-044.pdf
Liikennevirasto Sisäinen tarkastus Tarkastusraportti Lisä- ja muutostöiden hankinnan asianmukaisuus	PDF	01.11.2017	Tarkastusraportti_Lisä- ja muutostyöt_2017.pdf
Hallitusohjelmaa toteuttava liikenne- ja viestintäministeriön ja Liikenneviraston välinen tulossopimus	PDF	02.01.2018	Tulossopimus 2018.pdf
Innovaatio- ja yhteistyökyky 2018 Tulosityhteenveto	PDF	2018	Tulosityhteenveto 2018, Liikennevirasto, Innovaatio- ja yhteistyökyky.pdf
Innovaatio- ja yhteistyökyky 2019	PDF	2019	VL- Tietopyyntö.emlTulosityhteenveto Tulosityhteenveto 2019, Väylävirasto, Innovaatio- ja yhteistyökyky.pdf
voxnet_maturana_scherer_iros15.pdf			
VoxNet: A 3D Convolutional Neural Network for Real-Time Object Recognition	PDF	-	voxnet_maturana_scherer_iros15.pdf
Väyläviraston tietopyyntöhinnasto	PDF	01.11.2019	Väylävirasto tietopyyntöhinnasto 1.11.2019.pdf

Väylävirasto ICT-teknologia-arkkitehtuuri kuvaus	PDF	-	Väyläviraston ICT-teknologia-arkkitehtuurin kuvaus.pdf
Hankinnan ohjeistus, EU-ali, Hankintailmoitus ja alustava tarjouspyyntö	PDF	-	EU-ali, Hankintailmoitus.pdf
Hankinnan ohjeistus, EU-ali, Tarjouspyyntö	PDF	-	EU-ali, Tarjouspyyntö.pdf
Hankinnan ohjeistus, EU-ali, Julkisuus	PDF	-	EU-ali, Julkisuus.pdf
Hankinnan ohjeistus, EU-ali, Muutoksenhaku	PDF	-	EU-ali, Muutoksenhaku.pdf
Hankinnan ohjeistus, EU-ali, Päätökset	PDF	-	EU-ali, Päätökset.pdf
Hankinnan ohjeistus, EU-ali, Sopimus ja arkistointi	PDF	-	EU-ali, Sopimus & arkistointi.pdf
Hankinnan ohjeistus, EU-ali, Tarjoajien valinta	PDF	-	EU-ali, Tarjoajien valinta.pdf
Hankinnan ohjeistus, EU-yli, Hankintailmoitus ja tarjouspyyntö	PDF	-	EU-yli, Hankintailmoitus & tarjouspyyntö.pdf
Hankinnan ohjeistus, EU-yli, Julkisuus	PDF	-	EU-yli, Julkisuus.pdf
Hankinnan ohjeistus, EU-yli, Muutoksenhaku	PDF	-	EU-yli, Muutoksenhaku.pdf
Hankinnan ohjeistus, EU-yli, Päätökset	PDF	-	EU-yli, Päätökset.pdf
Hankinnan ohjeistus, EU-yli, Sopimus ja arkistointi	PDF	-	EU-yli, Sopimus & arkistointi.pdf
Hankinnan ohjeistus, EU-yli, Tarjoajien valinta	PDF	-	EU-yli, Tarjoajien valinta.pdf
Hankinnan ohjeistus, EU-yli, Tarjousaika	PDF	-	EU-yli, Tarjousaika.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Hankintailmoitus ja alustava tarjouspyyntö	PDF	-	Neuv.men, Hankintailmoitus ja alustava tarjouspyyntö.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Julkisuus	PDF	-	Neuv.men, Julkisuus.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Muutoksenhaku	PDF	-	Neuv.men, Muutoksenhaku.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Neuvottelut ja lopullinen tarjouspyyntö	PDF	-	Neuv.men, Neuvottelut ja lopullinen tp.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Päätökset	PDF	-	Neuv.men, Päätökset.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Pyyntö jättää alustava tarjous	PDF	-	Neuv.men, Pyyntö jättää alustava tarjous.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Sopimus ja arkistointi	PDF	-	Neuv.men, Sopimus & arkistointi.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Tarjoajien valinta	PDF	-	Neuv.men, Tarjoajien valinta.pdf

Hankinnan ohjeistus, Puitejärjestelyn kilpailuttaminen	PDF	-	Puitejärjestelyn kilpailuttaminen.pdf
Hankinnan ohjeistus, Puitejärjestelyt	PDF	-	Puitejärjestelyt.pdf
Hankinnan ohjeistus, Puitejärjestelyyn perustuvat hankinnat	PDF	-	Puitejärjestelyyn perustuvat hankinnat.pdf
Pyyntöne koskien sidosryhmäanalyysiä	Sähköposti	30.10.2020	VS- Pyyntöne koskien sidosryhmäanalyysiä.eml
Tukipyynnö opinnäytetyöaineiston saamiseksi	Sähköposti	27.11.2020	VS- Tukipyynnö opinnäytetyöaineiston saamiseksi.eml
Tietopyynnö	Sähköposti	19.01.2021	VL- Tietopyynnö.eml
Omia mietteitä lähteistä	Sähköposti	24.09.2020	Omia mietteitä lähteistä.eml
Tietopyynnö: Opinnäytetyön	Sähköposti	22.09.2020	Re- Tietopyynnö- Opinnäytetyön.eml
Vastaus tietopyynnöönne: Ohjelmistoinfrastruktuuri (VÄYLÄ/7082/01.03.01/2020)	Sähköposti	27.10.2020	Vastaus tietopyynnöönne- Ohjelmistoinfrastruktuuri (VÄYLÄ-.7082-01.03.01-2020).eml
Tietopyynnö: Korruptiontunnistus	Sähköposti	01.02.2021	VL- Tietopyynnö- Korruptiontunnistus.eml
Tietopyynnö: Opinnäytetyön - hankintatiedot	Sähköposti	11.12.2020	VL- Tietopyynnö- Opinnäytetyön - hankintatiedot.eml
Tietopyynnö: Opinnäytetyön	Sähköposti	19.08.2019	VL- Tietopyynnö- Opinnäytetyön.eml
Tietopyynnö: Opinnäytetyön	Sähköposti	11.05.2020	VL- Tietopyynnö- Opinnäytetyön[1].eml
Tietopyynnö: Opinnäytetyön	Sähköposti	22.05.2020	VL- Tietopyynnö- Opinnäytetyön[2].eml
Pyyntöne koskien sidosryhmäanalyysiä	Sähköposti	19.10.2020	S- Pyyntöne koskien sidosryhmäanalyysiä.eml
Tietopyynnö- Opinnäytetyön	Sähköposti	05.10.2019	VS- Tietopyynnö- Opinnäytetyön.eml
Tietopyynnö- Opinnäytetyön	Sähköposti	06.08.2019	VS- Tietopyynnö- Opinnäytetyön.eml
Tietopyynnö: Opinnäytetyön	Sähköposti	22.06.2020	VS- Tietopyynnö- Opinnäytetyön[1].eml
Tietopyynnö: Opinnäytetyön	Sähköposti	05.06.2020	VS- Tietopyynnö- Opinnäytetyön[2].eml
Tietopyynnö: Opinnäytetyön	Sähköposti	20.07.2020	VS- Tietopyynnö- Opinnäytetyön[3].eml
Tilintarkastajan väliraportti Liikenneviraston hankintamenettelyiden laillisuus- ja	PDF	12.02.2019	456_LiVi_vr_hankinnat_2018_J OK_MLT.pdf

asianmukaisuustarkastuksesta			
Tilintarkastajan vuosiyhteenveto	PDF	30.04.2019	456_LiVi_vyv_2018.pdf
Tilintarkastajan väliraportti Väyläviraston hankintojen laillisuus- ja asianmukaisuustarkastuksesta	PDF	03.01.2020	4560_vayla_vr_hankinnat_2019.pdf
Tilintarkastajan vuosiyhteenveto	PDF	28.04.2020	4560_vayla_vyv_2019.pdf
Liikennevirasto / Finnish Transport Agency	PDF	-	Appendix 3 Pricing - Liite 3 Hinnat.pdf
Regulation	PDF	16.11.2011	Appendix 6.i - Preparatory phase plan.pdf
Radantarkastuspalvelut - Track inspection services Yhteyshenkilöt / Contact persons	PDF	-	Appendix 9 Contract Persons - Liite 9 Yhteyshenkilöt.pdf
Hallituksen esitys eduskunnalle laiksi Liikenne- ja viestintäviraston perustamisesta, Liikennevirastosta annetun lain muuttamisesta ja eräksi niihin liittyviksi laeiksi	PDF	-	asiakirja_258189.pdf
Selvitys rautateiden tavaraliikenteen kilpailun edellytyksistä	PDF	24.05.2018	asiakirja_271370.pdf
Getting started with BIM for building design	PDF	-	autodesk-ebook-bim-getting-started-guide-bldgs-en.pdf
Euroopan parlamentin ja neuvoston direktiivi 2012/34/EU	PDF	14.12.2012	CELEX%3A32012L0034%3AFI%3ATXT.pdf
Civil engineering benefits of BIM	PDF	-	civil-engineering-ebook-benefits-of-bim-en.pdf
Code of conduct	PDF	04.01.2021	Code of conduct - Väylä.pdf
Euroopan parlamentin ja neuvoston asetus (EU) N:o 1315/2013	PDF	20.12.2013	DOC_1.pdf
Esteellisyysäännöksiä koskeva ohje Väyläviraston henkilöstölle	PDF	02.09.2019	Esteellisyysäännöksiä koskeva ohje Väyläviraston henkilöstölle_lopullinen-1.pdf
Hankintakategoriaraportti - Sopimus	xlsx	02.01.2009	Hankintakategoriaraportti_digitalisaatio.xlsx
Hankintatoimen kehittämishankkeen loppuraportti: Tulokset sekä toimenpide- ja kehittämissuositukset	PDF	06/2016	Hankintatoimen kehittämishankkeen loppuraportti 6_2016.pdf
Hankintatutka 2020 -kyselyn tulokset	PDF	22.09.2020	Hankintatutka_2020.pdf
Digitaalinen tieto, innovatiiviset palvelut, hyvät yhteydet Liikenne- ja viestintäministeriön hallinnonalan konsernistrategia 2016–2020	PDF	01/2016	Henri_1_2048px_bw.pdf
Statement of Work	PDF	08.04.2020	HQ Systems Subcontractor Statement of Work_Docker setup

			(4).pdf
Rakenteellinen korruptio	PDF	04/2015	Korruptio Suomessa - Vaasan yliopisto.pdf
Järjestelmäkuvaukset väylä	xlsx	-	järjestelmäkuvaukset_väylä.xlsx
LIITE 1: Palvelun tuottamista koskevat vaatimukset	PDF	-	Liite 1 Palvelun tuottamista koskevat vaatimukset.pdf
LIIKENNEVIRASTO - Radantarkastuspalvelut liite 2 Valmisteluvaiheen vaatimukset	PDF	-	Liite 2 Valmisteluvaiheen vaatimukset.pdf
Liikenneviraston tietoaaineistojen käsittelyohje yhteistyökumppaneille	PDF	24.03.2015	Liite 4 Tietoaaineistojen käsittelyohje.pdf
Tulosopimuksen mukaiset tavoitteet 2016	PDF	2016	Livi_osavuosisiraportointi_2016.pdf
Tulosneuvottelut, syksy 2017	PDF	2017	Livi_osavuosisiraportointi_2017.pdf
Tulosneuvottelut 2018	PDF	2018	Livi_Osavuosisiraportointi_2018.pdf
Liikenneviraston tutkimuksia ja selvityksiä Rataverkon kokonaiskuva	PDF	2018	Its_2018-37_rataverkon_kokonaiskuva_web.pdf
Liikenne- ja viestintäministeriön talousarvioehdotus	PDF	2018	LVM TAE 2018 10.8.2017.pdf
TAE 2019 LVM ehdotus	PDF	-	LVM TAE 2019 vertailu.pdf
Talousarvioesitys 2019, Ministeriön ehdotus	PDF	09.08.2018	LVM TAE 2019, 9.8.2018 .pdf
Miika Mäkitalo Market Entry and the Change in Rail Transport Market when Domestic Freight Transport Opens to Competition in Finland	PDF	2007	makitalo.pdf
Väylävirasto Osavuosisiraportointi syksy 2019	xlsx	2019	Osavuosisiraportointi_syksy_2019_Väylä.XLSX
Uusi radantarkastuspalvelu ja tietojen hyödyntäminen Tuomo Viitala, Pikkurata	PDF	15.03.2017	Pikkurata.pptx.pdf
Väyläviraston voimassa olevat puitejärjestelyt	xlsx	16.05.2019	Puitejärjestelyt_Vayla.xlsx
Puitesopimusten toteumat tilauksittain	xlsx	2018, 2019	Puitesopimusten toteumat tilauksittain_2018_2019.xlsx
Puitesopimusten toteumat tilauksittain	xlsx	2019	Puitesopimusten toteumat tilauksittain_2019.xlsx
Valtion rataverkko	PDF	01.01.2018	Rataverkko2018_web.pdf
Sopimusmuutos sopimukseen Radantarkastuspalvelut	PDF	30.09.2016	Sopimus optioista.pdf
Sopimus Liikennevirasto Radantarkastus	PDF	24.05.2016	Sopimus VT-044.pdf

Liikennevirasto Sisäinen tarkastus Tarkastusraportti Lisä- ja muutostöiden hankinnan asianmukaisuus	PDF	01.11.2017	Tarkastusraportti_Lisä- ja muutostyöt_2017.pdf
Hallitusohjelmaa toteuttava liikenne- ja viestintäministeriön ja Liikenneviraston välinen tulossopimus	PDF	02.01.2018	Tulossopimus 2018.pdf
Innovaatio- ja yhteistyökyky 2018 Tulosityhteenveto	PDF	2018	Tulosityhteenveto 2018, Liikennevirasto, Innovaatio- ja yhteistyökyky.pdf
Innovaatio- ja yhteistyökyky 2019	PDF	2019	VL- Tietopyyntö.emlTulosityhteenveto Tulosityhteenveto 2019, Väylävirasto, Innovaatio- ja yhteistyökyky.pdf
voxnet_maturana_scherer_iros15.pdf	PDF	2015	VoxNet: A 3D Convolutional Neural Network for Real-Time Object Recognition
VoxNet: A 3D Convolutional Neural Network for Real-Time Object Recognition	PDF	-	voxnet_maturana_scherer_iros1 5.pdf
Väyläviraston tietopyyntöhinnasto	PDF	01.11.2019	Väylävirasto tietopyyntöhinnasto 1.11.2019.pdf
Väylävirasto ICT-teknologia-arkkitehtuuri kuvaus	PDF	-	Väyläviraston ICT-teknologia-arkkitehtuurin kuvaus.pdf
Hankinnan ohjeistus, EU-ali, Hankintailmoitus ja alustava tarjouspyyntö	PDF	-	EU-ali, Hankintailmoitus.pdf
Hankinnan ohjeistus, EU-ali, Tarjouspyyntö	PDF	-	EU-ali, Tarjouspyyntö".pdf
Hankinnan ohjeistus, EU-ali, Julkisuus	PDF	-	EU-ali, Julkisuus.pdf
Hankinnan ohjeistus, EU-ali, Muutoksenhaku	PDF	-	EU-ali, Muutoksenhaku.pdf
Hankinnan ohjeistus, EU-ali, Päätökset	PDF	-	EU-ali, Päätökset.pdf
Hankinnan ohjeistus, EU-ali, Sopimus ja arkistointi	PDF	-	EU-ali, Sopimus & arkistointi.pdf
Hankinnan ohjeistus, EU-ali, Tarjoajien valinta	PDF	-	EU-ali, Tarjoajien valinta.pdf
Hankinnan ohjeistus, EU-yli, hankintailmoitus ja tarjouspyyntö	PDF	-	EU-yli, Hankintailmoitus & tarjouspyyntö".pdf
Hankinnan ohjeistus, EU-yli, Julkisuus	PDF	-	EU-yli, Julkisuus.pdf
Hankinnan ohjeistus, EU-yli, Muutoksenhaku	PDF	-	EU-yli, Muutoksenhaku.pdf
Hankinnan ohjeistus, EU-yli, Päätökset	PDF	-	EU-yli, Päätökset.pdf
Hankinnan ohjeistus, EU-yli, Sopimus ja arkistointi	PDF	-	EU-yli, Sopimus & arkistointi.pdf

Hankinnan ohjeistus, EU-yli, Tarjoajien valinta	PDF	-	EU-yli, Tarjoajien valinta.pdf
Hankinnan ohjeistus, EU-yli, Tarjousaika	PDF	-	EU-yli, Tarjousaika.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Hankintailmoitus ja alustava tarjouspyyntö	PDF	-	Neuv.men, Hankintailmoitus ja alustava tarjouspyyntö.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Julkisuus	PDF	-	Neuv.men, Julkisuus.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Muutoksenhaku	PDF	-	Neuv.men, Muutoksenhaku.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Neuvottelut ja lopullinen tarjouspyyntö	PDF	-	Neuv.men, Neuvottelut ja lopullinen tp.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Päätökset	PDF	-	Neuv.men, Päätökset.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Pyyntö jättää alustava tarjous	PDF	-	Neuv.men, Pyyntö jättää alustava tarjous.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Sopimus ja arkistointi	PDF	-	Neuv.men, Sopimus & arkistointi.pdf
Hankinnan ohjeistus, Neuvottelumenettely, Tarjoajien valinta	PDF	-	Neuv.men, Tarjoajien valinta.pdf
Hankinnan ohjeistus, Puitejärjestelyn kilpailuttaminen	PDF	-	Puitejärjestelyn kilpailuttaminen.pdf
Hankinnan ohjeistus, Puitejärjestelyt	PDF	-	Puitejärjestelyt.pdf
Hankinnan ohjeistus, Puitejärjestelyyn perustuvat hankinnat	PDF	-	Puitejärjestelyyn perustuvat hankinnat.pdf
Pyyntöne koskien sidosryhmäanalyysiä	Sähköposti	30.10.2020	VS- Pyyntöne koskien sidosryhmäanalyysiä.eml
Tukipyyntö opinnäytetyöaineiston saamiseksi	Sähköposti	27.11.2020	VS- Tukipyyntö opinnäytetyöaineiston saamiseksi.eml
Tietopyyntö	Sähköposti	19.01.2021	VL- Tietopyyntö.eml
Omia mietteitä lähteistä	Sähköposti	24.09.2020	Omia mietteitä lähteistä.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.09.2020	Re- Tietopyyntö- Opinnäytetyön.eml
Vastaus tietopyyntöönne: Ohjelmistoinfrastrukturi (VÄYLÄ/7082/01.03.01/2020)	Sähköposti	27.10.2020	Vastaus tietopyyntöönne- Ohjelmistoinfrastrukturi (VÄYLÄ-.7082-01.03.01-2020).eml
Tietopyyntö: Korruptiontunnistus	Sähköposti	01.02.2021	VL- Tietopyyntö- Korruptiontunnistus.eml
Tietopyyntö: Opinnäytetyön - hankintatiedot	Sähköposti	11.12.2020	VL- Tietopyyntö- Opinnäytetyön - hankintatiedot.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	19.08.2019	VL- Tietopyyntö-

			Opinnäytetyön.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	11.05.2020	VL- Tietopyyntö- Opinnäytetyön[1].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.05.2020	VL- Tietopyyntö- Opinnäytetyön[2].eml
Pyyntöne koskien sidosryhmäanalyysiä	Sähköposti	19.10.2020	S- Pyyntöne koskien sidosryhmäanalyysiä.eml
Tietopyyntö- Opinnäytetyön	Sähköposti	05.10.2019	VS- Tietopyyntö- Opinnäytetyön.eml
Tietopyyntö- Opinnäytetyön	Sähköposti	06.08.2019	VS- Tietopyyntö- Opinnäytetyön.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.06.2020	VS- Tietopyyntö- Opinnäytetyön[1].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	05.06.2020	VS- Tietopyyntö- Opinnäytetyön[2].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	20.07.2020	VS- Tietopyyntö- Opinnäytetyön[3].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.09.2020	Re- Tietopyyntö- Opinnäytetyön.eml
Vastaus tietopyyntöönne: Ohjelmistoinfrastruktuuri (VÄYLÄ/7082/01.03.01/2020)	Sähköposti	27.10.2020	Vastaus tietopyyntöönne- Ohjelmistoinfrastruktuuri (VÄYLÄ-.7082-01.03.01-2020).e ml
Tietopyyntö: Korruptiontunnistus	Sähköposti	01.02.2021	VL- Tietopyyntö- Korruptiontunnistus.eml
Tietopyyntö: Opinnäytetyön - hankintatiedot	Sähköposti	11.12.2020	VL- Tietopyyntö- Opinnäytetyön - hankintatiedot.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	19.08.2019	VL- Tietopyyntö- Opinnäytetyön.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	11.05.2020	VL- Tietopyyntö- Opinnäytetyön[1].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.05.2020	VL- Tietopyyntö- Opinnäytetyön[2].eml
Pyyntöne koskien sidosryhmäanalyysiä	Sähköposti	19.10.2020	S- Pyyntöne koskien sidosryhmäanalyysiä.eml
Tietopyyntö- Opinnäytetyön	Sähköposti	05.10.2019	VS- Tietopyyntö- Opinnäytetyön.eml
Tietopyyntö- Opinnäytetyön	Sähköposti	06.08.2019	VS- Tietopyyntö- Opinnäytetyön.eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.06.2020	VS- Tietopyyntö- Opinnäytetyön[1].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	05.06.2020	VS- Tietopyyntö-

			Opinnäytetyön[2].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	20.07.2020	VS- Tietopyyntö- Opinnäytetyön[3].eml
Tietopyyntö: Opinnäytetyön	Sähköposti	22.09.2020	Re- Tietopyyntö- Opinnäytetyön.eml
Vastaus tietopyyntöönne: Ohjelmistoinfrastruktuuri (VÄYLÄ/7082/01.03.01/2020)	Sähköposti	27.10.2020	Vastaus tietopyyntöönne- Ohjelmistoinfrastruktuuri (VÄYLÄ-.7082-01.03.01-2020).e ml

4.3. Analysis methods

Based on David E Gray mixing qualitative and quantitative analysis and inductive and deductive reasoning is a common research method. Outcomes from qualitative study are commonly used for informing the quantitative research phase. The method is commonly used in circumstances when little or nothing is known of the research problem. David E Gray states that it would be impractical to determine to design a questionnaire when the research subject is not sufficiently understood. Qualitative design provides clarity for quantitative analysis by studying, exploring and identifying variables required for quantitative research. [8]

Inductive and deductive reasoning are used in the thesis. Inductive reasoning is used when collecting and analyzing data in literature review and determining quantitative questions for the second part of analysis. In the second part of analysis deductive reasoning is applied in quantitative analysis.

Inductive reasoning includes determining the mission of the target organization, hypothesis, operationalizing and examining outcomes. Deductive reasoning is used for quantitative analysis of how well the target organization's organizational change has caused outcomes determined in government official documentation before the change was implemented. Deductive reasoning is used in examining outcomes. [8]

5. RESEARCH RESULTS

This chapter presents the overview of Finnish Transportation Infrastructure Agency

5.1. Legislation bases

According to Finnish legislation, Finnish Transportation Infrastructure Agency operates under jurisdiction of Finnish Ministry of Transportation and Communications. It's mission is to maintain and develop government owned road, railway and waterway infrastructure. Legislation also determines that part of the Agency's responsibilities is to foster functionality, automation, transportation safety, sustainable development as part of the overall transportation system together with regional and business sectors operating premises and balanced development. Agency operation is based on customer focus strategy and it utilizes expertise. Its operations are predictive and are based on knowledge and risk analysis. Legislation states the operations region of the Agency to be within the region of Finland. [9]

“Legislation states that tasks of the Agency are:

1. is responsible for the state road and rail network and waterways managed by them and for their development and for the coordination of measures concerning them throughout the country;
2. limit the environmental damage caused by traffic;
3. is responsible for organizing traffic control;
4. promote the digitalisation and automation of transport services and the transport system;
5. is responsible for the maintenance and service level of roads, the construction of significant road projects and national tasks of road maintenance, as well as the planning, construction, maintenance and service level of railways and waterways;

6. is responsible for the operational management of the business, transport and environmental centers in its field and for the coordination of road maintenance in the said centers;
7. is responsible for and manages data resources concerning fairways, takes care of statistics in its field and co-operation concerning traffic and fairway information;
8. secure the conditions for winter navigation;
9. promote the functioning of the fairway market;
10. take care of the preparation of its own activities for disturbances and exceptional circumstances under normal conditions and promote the preparation of society for disturbances and exceptional conditions under normal conditions in its field of activity; mixed
11. nurtures and manages culturally and historically valuable real estate objects, cultural environments and cultural property under its control.
12. The Finnish Rail Agency participates in the planning of transport systems and the preparation of transport network measures, as well as in land use co-operation as an expert in waterway maintenance and as a holder of waterway assets. The agency is also involved in coordinating transport and land use, as well as in drawing up a national transport system plan and regional transport system planning with provincial associations, municipalities, urban areas and other actors.

In addition, the Agency may:

13. to conclude, within the scope of its powers, international agreements of a technical nature which do not concern the field of legislation; and
14. participate in international co-operation in their field.
15. The Agency shall also be responsible for such other tasks in its field as are specifically assigned to it.” [9]

5.2. Agency strategy bases

“A functioning network of transport infrastructure makes well-being, competitiveness, and sustainable growth possible in Finland

The strategy of the Finnish Transport Infrastructure Agency (FTIA) looks to the future, enabling the new agency to do things in a new way.

FTIA is a skilled procurement organisation responsible for roads, rail services, and waterways. It participates in transport system work aimed at promoting the easy movement of people and the efficient transport of goods by the world of business.

Management of our transport infrastructure property is to be more long-term, proactive, and responsive to customer needs. The information-based management of the condition of transport infrastructure and a high level of expertise in procurement create a strong foundation for efficient and effective transport infrastructure management and construction. A focus on the customer and securing day-to-day safety and functionality form the foundation of our activities.

FTIA has a central role when we respond to the effects of climate change through transport infrastructure maintenance. In transport system planning, priority must be given to solutions promoting sustainable transport. The impact of the construction and maintenance of transport infrastructure on climate requires more attention, and the reduction of emissions also needs to be advanced through means of infrastructure maintenance.

The core of the FTIA operating culture is based on values that we share with our personnel: trust, open cooperation, and expertise with a capability for renewal. This is how we also want to operate without our stakeholders and customers.” [10]

5.3. Agency code of conduct bases

“Code of Conduct

The Finnish Transport Infrastructure Agency’s Code of Conduct outlines our best practices and ethical behaviour. The code is not legally binding, but recommends good practices to be followed in all our activities.

We strive to work in the best interest of society and our customers.

- We have been assigned the tasks under our jurisdiction through statutes.
- We perform our tasks expertly, promptly, impartially, fairly and efficiently.
- We contribute our expertise for the benefit of society on transparent grounds.
- We promote the goals set for us by democratically elected decision-makers.

We allocate the granted appropriations responsibly.

- Our actions are thoroughly planned. Our decisions have been carefully considered and their impact assessed.
- In all our resolutions and implementations, we strive to reach economically, socially and environmentally sustainable solutions.
- By maintaining our expertise, and by developing our activities and our procedures, we strive to promote a well-functioning transport system that will continue to contribute to the welfare of society in the future.
- In our work to develop the transport system, the best result for society is achieved through fruitful cooperation with various actors that consider alternative solutions together.

We value our expertise and our stakeholders.

- We make sure that our expertise is visible in our solutions.

- We consider our stakeholders' opinions when planning and implementing our work.
- Through our interaction with citizens, our expertise is demonstrated, for example, by considering any potential opposing views, which can be voiced at public meetings regarding transport infrastructure projects.
- We comply with our contracts and are loyal contract partners.
- We actively report our activities and welcome any feedback on it.

We treat each other with respect, impartially and fairly.

- Good cooperation is based on each individual's contributions.
- We perform our own tasks, while taking our colleagues into account and sharing the workload.
- We do not tolerate any form of discrimination, bullying or similar behaviours. We deal with problems, not by talking behind people's backs, but rather by quickly addressing the problems and together working to find a solution, with the aim of creating a good working atmosphere for each and every one.

We do not accept any form of corruption.

- Our collaboration with stakeholders is important. Since the field of actors in the transport sector is rather restricted, we pay special attention to being impartial, especially in direct procurement and when setting selection criteria.
- As a rule, we turn down gifts offered by service providers, but do accept minor gifts on special occasions, for example.

We operate proactively in an open and transparent way.

- We openly disclose information regarding our projects and our collaboration with stakeholders.
- Our official documents and open data is readily available to anyone.
- There are no hidden motives behind our solutions.

- We report any potential commitments well in advance.

Ethical values are tested every day in big and small ways.

- We serve as each other's role models.
- Our daily actions count: we greet each other equally, we do not cover up any mistakes, we check in and out properly, we form working groups with people of various opinions.
- Through our own actions, we communicate that we expect the same ethical values from our stakeholders.
- Everyone is responsible for acting ethically. The importance of ethical behaviour is regularly emphasised by the management.” [10]

5.4. Agency's operation philosophy

“FTIA is an expert agency of about 400 people, concentrating on planning, developing, and maintaining road, rail, and maritime transport infrastructure and the coordination of transport and land-use. In addition, it is also responsible for arranging traffic control and winter navigation. FTIA will operate in the planning of transport systems as the primary partner of regional councils, municipalities, urban regions, and other players.

Finnish Transport Infrastructure Agency deals with the service level of transport, thus promoting well-being in Finnish society and Finnish business competitiveness. FTIA's task is to respond efficiently and responsibly to customer needs arising from changes in transportation and to produce a growth platform for society in the form of a functional and safe infrastructure. In addition, we do our part to promote development and responsible construction in the infrastructure field.

FTIA operates within the administrative purview of the Ministry of Transport and Communications.

Our job – by road, rail, and sea

- Transport network planning

- Developing transport routes
- Maintaining the standard of service of transport routes
- Coordinating transport and land use
- Winter navigation
- Organising traffic management

Cooperation across organisational boundaries

The division of tasks and interface with FTIA will be as follows:

On 1 January 2019, the traffic control tasks for road traffic, rail traffic, and maritime routes were incorporated into Traffic Management Finland Group. This is an external link, a state-owned company with a special task. FTIA will order services for traffic control from the company.

Regional maintenance of roads will continue to be the responsibility of Finland's ELY Centres (link). FTIA will deal with the implementation of the national level of service. Daily road maintenance will be handled by contractors on based on competitive tenders.

Founded at the beginning of 2019, the new Transport and Communications Agency Traficom. This is an external link will be responsible for transport licences, qualifications, supervision, and safety.” [11]

Infrastructure provides a platform for growth



Picture 2. Illustration of Finnish Transportation Agency's key figure. [12]

In comparison, Finnish government budget for 2021 was set to 65,2 billion. [13]

5.5. Agency's ICT infrastructure

As part of the research, brief research on the Agency's ICT systems and infrastructure was conducted. Purpose of the research was to gain understanding of what kind of data could be available for efficient recognition of corruption indicators.

Hypothesis was set to factor that if quantitative procurement data would be available, relation between operational data and procurement data can be investigated and methodologies for further quality surveillance can be applied to public procurement. As no valid procurement data was available on target institute, relation hypothesis could not have been tested during the research.

Agency has following systems that could provide operational data for recognition purposes:

Table 2. List of Agency's ICT systems. [14]

System name	Description
Sampo	planning and monitoring of activities and budgeting. Master of contract information for Harja, Raid-E and Reimar
Marshalling yard control system Tampere	Automatic control of marshalling yard and train assembly
PrettyLib	library collection database, used to manage a book collection. The collection itself is mostly located on the 22nd floor of the Road Casino. PrettyLib's life cycle ends in 2-3 years.
Kameleon	Publishing system
SIEM	SIEM collects event data from systems and environments centrally.
Emma	Measurement data of track condition and geometry (so-called Emma map results).
Optima	an online learning environment for learning and teaching
RFID	Readers for rail vehicle identification
SITEINFO / RATAPORTTI	Property manager information system
Road register	Thematic database on the characteristics of public roads for the needs of road maintenance planning, maintenance commissioning and project-specific pre-planning.
Digiroad - road network management application (VVH)	The VVH application maintains the road and street network in a data model according to the link node model. The application can be used to modify the road network, add new road sections, links or intersections, and maintain the geometry of links and nodes. The system provides up-to-date road network information to other systems. The VVH application manages and maintains spatial data related to the road network. In the future, data according to the road address network may also be transferred under the VVH application (Road address reference frame)

AD	Microsoftin LDAP
RAILI-verkko (GSM-R)	Railway communication system in accordance with the GSM-R standard. Dicora is a traffic control telephone system. Replaces the RAILI service, which can be used with VIRVE radios and smartphones with the RAPLI application.
Cognos	Finnish Transport Agency's reporting portal with many different applications such as Tiira, Sampo / financial reporting, Plan reporting.
Tarva MT	The system assesses the impact on road safety of various measures that change the road or traffic conditions.
System email	Cross-system email traffic management system. Can also be used as a backup email system.
Image data warehouse	Bus maintenance image data warehouse Also includes weather camera images from 18 months
AIS-palvelu	Module for distribution, conversion and filtering of AIS data retrieved from an external source
Tarva LC	Railway safety assessment system. The system can be used to plan the effects of different measures on the accident prone of level crossings. In addition, the system allows level crossings to be classified into a condition category,
HARJA	<p>Harja is a contract management and reporting system. The brush receives information about the measures from the contractors automatically through interfaces and manual data entry, information about the conditions on the fairways and feedback from the fairway users on the condition of the fairways, as well as information from the Finnish Meteorological Institute and possibly other parties. The brush collects this information and compares the whole to the contracts. Current development work focuses on road maintenance, Harja focuses on contractual monitoring and the cost of measures.</p> <p>Monitoring of the implementation of regional maintenance contracts in terms of both quality and costs. Data collection on the maintenance contracts of the Fairway Agency / ELYs, eg for environmental reporting. Replaced Aura and Liito</p>

infraRYL-julkaisu	Common general quality requirements for construction in the infrastructure sector. A publication that can be purchased from Rakennustieto Oy as a book or viewed and partly printed as an online version on the basis of a license purchased from Rakennustieto Oy. The publication defines the general quality requirements for the materials and construction of infrastructure structures (eg roads, tracks, streets, sewers, and their equipment). The Finnish Transport Agency and many municipalities have replaced their previous general quality requirements with this.
LAM	History database of the automatic traffic measurement system and application for maintenance of measurement data and metadata.
Sonja	Service bus (Sonic ESB CA Suite)
IBNet	Operational control of winter shipping
SOA - OSB	SOA Suite Oracle ESB
AVA	Material Transfer Platform, a service intended for the distribution of material by the Finnish Rail Administration
HA proxy	SOA Office API management tool
PTP	Management, analysis and visualization of spatial data sets. Includes the agency's shared spatial data server, database and user interface applications.
Emma-map	Mapping the geometry and condition of the network
RataDW	Data Warehouse, LOKI and LIIKE data reporting
IBNet: A note on board of a ship	IBNet: A note on board of a ship
TURI	Track safety deviation and risk management information system
Exchange (email service)	Email service from the service provider
WebScada	Management of safety device error messages.
Proha	Management and monitoring of waterway projects (pts), retrieves information from waterway registers and makes summaries.
Skill structure register: Mobile application	A separate mobile application with which the general inspection data of bridges and drums can be entered in the Skills Structure Register

FIM	Identity Management System (IDM)
VARE	Register of secured areas. Area information on measured / surveyed areas where marine measurements have been made. Marine survey index that tells what measurements have been made in which area (register of secured areas requires GeoMedia to work)
YHA	Pavement Design (Maintenance Management System)
Tiekuva.com	Road still pictures
VEKU	Track-side monitoring device: wheel force indicator. Part of VALTSU.
GeoNAVI	Official waterway data and maritime safety equipment data (Requires GeoMedia)
RAID-e Ratko	RATKO is a management system for track destinations and their location information. The information contained in the RATKO database forms the so-called master information that is utilized by various stakeholders. RATKO's database involves direct users and use cases, but in the future the information and its utilization will take place more through service interfaces in various utilization applications, such as track maintenance control, track inspection and track work control.
RAID-e Raiku	A tool for recording track maintenance observation, inspection and action information.
FME	Analysis and export of spatial data, compilation of data from basic registers.
Alfresco	Document management
Data catalog	Complete architecture tool, information and system architecture maintenance
Skill structure register	The Skills Structure Register is a basic data repository for skill structures. In addition to administrative and structural information, it contains e.g. damage and condition information on bridges, tunnels, railway drums, sea signs, road and connecting berths and canal structures.
Level crossing service	Level crossing information in the ArcGis spatial information system
Tilaaja-Reimari	Centralized register of maritime security equipment

	maintenance events
LAKU	Bearing hot running system, part of VALTSU
Liferay -portaali	Browser-based Liferay portal service. The service has an extranet and an intranet, through which the Vintra intranet and the Extranet.vayla.fi service of the Finnish Railways, among others, are published. The environment produces e.g. Authorization management service, as well as Procurement guidance service.
OAG	Oracle API Gateway, access control
Intranet	Intranet portal
IVAR3	Traffic engineering impact model, which is used to prepare cost-benefit calculations for road projects and to carry out impact analyzes.
OAM	Oracle Access Manager, access control (browser)
Emme	Forecasting and statistics software for passenger and freight traffic. Used in Finland by most traffic administration authorities. For more information: http://www.inrosoftware.com/en/products/emme/
Case management system	The case handling system is an information system for the management, processing and archiving of matters and documents falling within the competence of the Finnish Transport Agency. It implements electronic archiving and electronic signing of documents. The case management system replaces the old slide application as a document register.
ESRI	ESRI licenses for different systems (PTJ, Tiira, KHJ as a platform, etc.)
Pooki	Map interface for browsing Navi registers (safety devices, buses, etc.). Recording of fault reports and sea warnings. Reporting system. Formerly called Webmap2
Marshalling yard Kouvola	Automatic control of marshalling yard and train assembly

RAID-e Ryhti	Track maintenance management system. Track maintenance management refers to the maintenance management of various railway assets managed by the Finnish Transport Agency. The task of maintenance is to ensure the daily operation of the tracks through continuous maintenance, such as maintenance, weather-related measures and fault repairs. Maintenance, on the other hand, looks at the life cycle status of track sites in an effort to identify sites at the end of the life cycle and their need for renewal and renewal, enabling economical and appropriate maintenance. The starting indicator for the need for maintenance can be e.g. the frequency and volume of failure of the track site, the measured or observed damage and the cumulative traffic load of the structure, ie the so-called gross tonnage data. Risk and safety assessment is also part of the planning. The track maintenance management system supports the maintenance planning process by systematizing the review of asset classes, the collection, processing and selection of action proposals for maintenance activities, and the planning and implementation of asset type-specific programs. The aim of the system is to increase the transparency and openness of planning and to intensify cooperation, producing a better set of measures. As a result of planned and coordinated planning, appropriate and economical track maintenance activities have become more efficient.
Kantavuuslaskentaportaali	Commissioning summer 2019. The load-bearing calculation portal compares the actual loads caused by overweight special transport vehicles according to the transport permit application with the loads caused by special transport diagrams stored on bridges. After the calculation, gives a proposal for the conditions for crossing the bridge. Master data from the Skills Structure Register.
Paku ja Roadis	Tools for editing and further processing the road register service file
View and download service	Spatial data sets are provided by open WMS and WFS interface services and a file download service. Included in the PTP package.
IBNet: Central node	IBNet: central node
Baltice.org	About Baltice.org Baltice.org is a single access point to reliable and up to date information related to winter navigation in the Baltic Sea area. This site gathers information and instructions from icebreaking authorities from all the Baltic Sea countries.

	The aim of the site is to extend the knowledge of winter navigation and prevailing conditions in the area during ice season.
Ratatiedon extranet (rhk.fi)	Track data extranet for sharing information with actors.
www.liikennevirasto.fi	Finnish Transport Agency's public website
Personec HR	Management of development discussion forms and certain competency information. View personal information, salary and employment information, and degree information.
URCA, RAILI-service platform	URCA provides railway operational voice communication services (RAILI service) and gateways in addition to the RAILI network to the public service radio network VIRVE and public mobile telephone networks. The RAILI service can be used with VIRVE radios and smartphones with the RAPLI application. The RAILI network (GSM-R) with its telephone will be decommissioned in spring 2019.
Webropol	Web-questionnaire
Railway Electrical network equipment register	A tool for registering electrical network equipment
Vine	Customer Information and Customer Relationship Management System (Buoy), formerly Vineyard
OID	Oracle Internet Directory, LDAP
Jira	Project management tool
Cogno work related to economics	This is not its own system, but a row created in the system table for budgeting
GeoMedia / Geomedia Pro (packet software)	Among other things, KARE and VARE's firmware
Digiroad	<p>Digiroad is a national information system that contains the central line geometry of the entire Finnish road and street network as well as the most important feature data. Digiroad provides a comprehensive, unified description of the transport network in digital form. The material enables the development and commercialization of various route planning, navigation, tourism and traffic telematics services.</p> <p>Digiroad's maintenance interface is the Property Information Management (OTH) application.</p>

Channel control system	System for channel traffic control. Operates channel surveillance cameras and monitors shutdown activity.
Lockl	Monitoring of channel traffic blockages and fault and maintenance information. Contractor for recording and browsing closure, traffic, maintenance and fault information (channel logbook)
Urakoitsija-Reimari	Maritime safety equipment maintenance event registration tool for contractors, source material from a subscriber reader. Data synchronization subscriber - contractor. Clients application for data transmission, local position
eOppiva	State digital learning environment

5.6. Answers to research questions

Political: What are goals set for the target organisation (legislation)?

According to Finnish legislation, Finnish Transportation Infrastructure Agency operates under jurisdiction of Finnish Ministry of Transportation and Communications. It's mission is to maintain and develop government owned road, railway and waterway infrastructure. Legislation also determines that part of the Agency's responsibilities is to foster functionality, automation, transportation safety, sustainable development as part of the overall transportation system together with regional and business sectors operating premises and balanced development. Agency operation is based on customer focus strategy and it utilizes expertise. Its operations are predictive and are based on knowledge and risk analysis. Legislation states the operations region of the Agency to be within the region of Finland. [9]

Economical: What are the economical incentives for stakeholders?

According to the Agency, it does not perform economic analysis as part of their stakeholder analysis. [15]

Social: Does institutional corruption exist in Finland and does it affect public procurement in FTIA's operations?

According to Aki Salminen research performed in Vaasa University level of corruption research in Finland is low and data, evidence and methodologies are in the development phase. Research also states that institutional corruption should not be taken lightly and suggests further research on the subject. [2]

The research mentioned above states that following risk factors occur during tendering processes. Each of the steps cause potential limitations for market entry and tendering participation. [2]

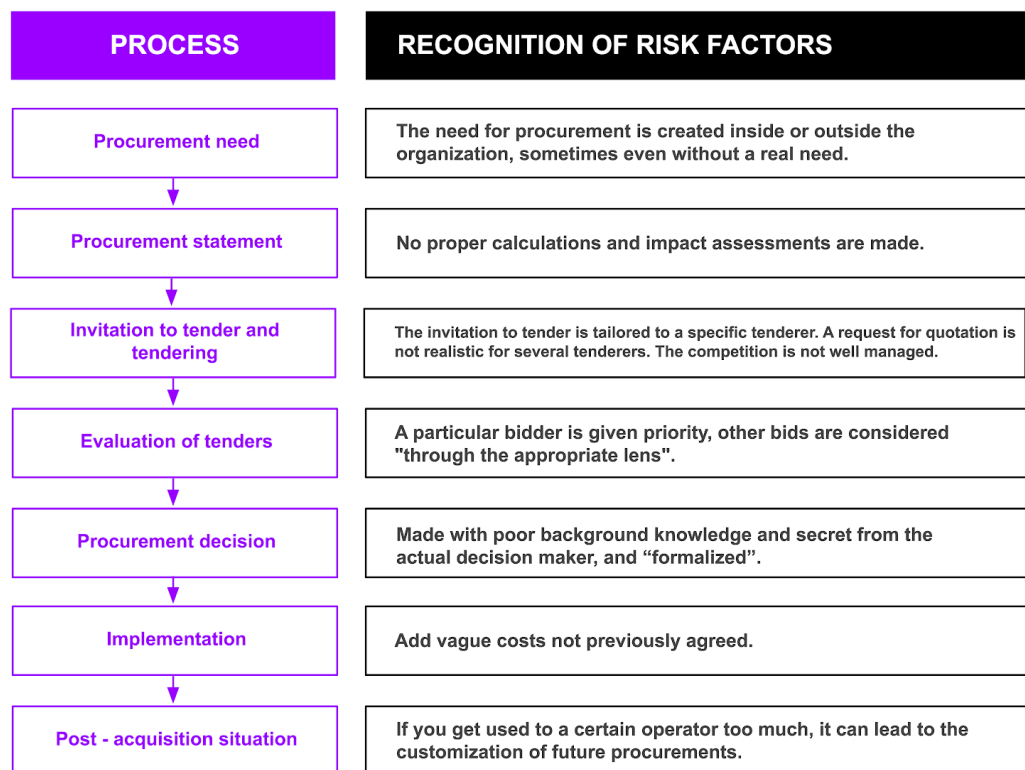


Chart 1. Illustration chart for institutional corruption risk indicators within the public purchasing process. [2]

Technological: Is there a quantitative method to use algorithms for recognition of corruption?

The agency does not apply any algorithms for detection of corrupted procurement methods during public tendering process. Nor the Agency have

any plans for implementing algorithms for the purpose. [16]

Environmental: What environmental requirements are related to public procurements in the target organisation?

Finnish Transportation Infrastructure Agency determinants environmental requirements on project bases and does not have common requirements for the purpose. [16]

Legal: How does the legislation affect the actions of operatives?

Two perspectives of legislative effects were evaluated during the research. Firstly on perspective of availability of procurement data and secondary effects of procurement law to public tendering methodologies.

Act on the Openness of Government Activities

Legislation related to availability of information of Agency's operations is determined in Act on the Openness of Government Activities. 3 § (9.8.2019/907) of the act states the purpose as follows:

“The purpose of the rights of access to information and obligations of public authorities provided for in this Act is to achieve transparency in the activities of public authorities and to enable individuals and entities to control the use of public power and funds, form freely express opinions and influence public authorities” [4]

Limitations on availability of information on public procurement are related to following exceptions in the act:

- 11 § participants rights to receive information point 6) in public procurement, information concerning the business secrets of another candidate or tenderer; however, information on the total price used to compare tenders must always be given; (10.8.2018 / 604)
- § 24 Confidential authority documents 17) documents which contain information on the business secrets of the state,

municipality or other public entity or an entity, institution or foundation referred to in section 4 (2), as well as documents which contain information on other similar business matters if disclosure would cause such entities; financial damage to institutions or foundations or would put another public or private entity engaged in similar or otherwise competing activities in a better competitive position or reduce the opportunities of a public entity or an entity, institution or foundation referred to in section 4 (2) for low-cost procurement or investment, financing and debt management arrangements; (10.8.2018 / 604)

- § 24 Confidential authority documents 20) documents containing information on private business secrets, as well as documents containing information on other similar aspects of private business, if disclosure would cause economic harm to the trader, and it is not a matter of protecting consumers' health or environmental health or rights; relevant information or information on the trader's obligations and how to perform them; (10.8.2018 / 604)
- Chapter 6 Confidentiality obligations § 22 Document confidentiality A document of an authority shall be kept secret if it is provided for confidentiality in this or another law, or if the authority has ordered it to be kept secret by law, or if it contains information which is subject to the obligation of professional confidentiality. A confidential official document or a copy thereof or a printout thereof shall not be shown or handed over to a third party or made available to a third party for viewing or use by technical access or otherwise.

Costs of information gathering Finnish Transportation Agency invoices 50 euros per starting ½ hour and minimum of one full hour per assignment. [17]

Agency officials ramifications for breaching confidentiality on their operations are determined in 19.12.1889/39 The criminal code of Finland

- § 1 (21.4.1995 / 578) Confidentiality

In breach of any obligation of professional confidentiality laid down by law or regulation or by a public authority

- 1) disclose a confidential matter of which he or she has become aware in his or her position, in the performance of his or her duties or in the performance of his or her duties, or
- 2) use such a secret for his own benefit or for the benefit of another,

shall be sentenced, unless the act is punishable under Chapter 40, Section 5, to a fine or imprisonment for a maximum of one year for a crime of confidentiality.

- § 2 (21.4.1995 / 578) Breach of confidentiality

If the breach of confidentiality, taking into account the importance of the act for the protection of privacy or confidentiality or other factors related to the crime, is, on the whole, minor, the offender must be fined for the breach of confidentiality.

A person who has committed a breach of the duty of confidentiality referred to in section 1, which has been separately provided for as a breach of confidentiality, shall also be convicted of a breach of confidentiality. [18]

Act on Public Procurement and Concession Contracts

According to the Finnish legislation, goals of public tendering are determined as follows:

“Section 2 Aims of the Act

(1) This Act seeks to enhance efficiency in the use of public funds, promote high quality, innovative and sustainable procurement, and safeguard equal opportunities for enterprises and other corporations in providing goods, services and public works contracts in competitive tendering for public procurement.

(2) Contracting entities shall endeavour to arrange their procurement operations so that procurements can be implemented with optimal

economy, quality and orderliness, taking advantage of existing competitive conditions and allowing for environmental and social aspects. To reduce the administrative functions involved in procurement, contracting entities may use framework agreements and make joint procurements or benefit from other opportunities for cooperation in competitive tendering for public procurement.

(3) Procurements shall be realised as expedient modules. Efforts shall be made to arrange procurements so that small and medium-sized enterprises and other corporations have equal access with other tenderers to participation in competitive tendering. Efforts shall be made to give consideration to adequate transparency and non-discrimination in procurements falling below the national threshold values referred to in this Act, having regard to the size and scope of the procurement.”[19]

Primary research question: How can institutional corruption be recognized efficiently?

Because of unavailability of required quantitative data on public procurement in Finnish Transportation Infrastructure Agency, corruption indicators described below are hypothetical and have not been tested with real data.

Aims of the public tenderings have been determined in 1397/2016

Act on Public Procurement and Concession Contracts. Aims include enhancing efficiency of usage of public funds and safeguarding equal opportunities for enterprises and corporations in competitive tendering for public procurement. [19]

Corruption poses risk of increased costs structure and decreased quality on publicly purchased goods or services. [2]

Efficient detection of corruption indicators in the tendering process without human intervention reliably is currently difficult. During this research, the most significant obstacle to generate automated methods for recognition was lack of availability of data. Following hypothesis models for recognition have been established based on a flagging system, which recognizes anomalies in public tendering methods. This flagging system can provide additional help on

targeting manual inspections to projects, instead of using random checking methodology that is currently used on implementations of surveillance of public tendering operations.

Morally corrupt tenderer

During author's own experience when working with public tenderings in the past, following three corrupted methodologies used by government officials during tendering operations has been detected:

Participation requirement manipulation

By setting participation limits, such as earlier project references, revenue requirements or combining several different operations into a single larger project, the tenderer is able to limit the amount of participants on public tenderings. In addition, methodology where participation limits can be lowered for a single project for enabling penetration of markets for selected operators.

Budget manipulation and additional work

By establishing a larger budget for the project and giving information of total budget to a single operator and promising additional work orders to the winning operator within the contract, tenderers can make it possible for a determined participant to win the project with lowest price and make the project profitable by implementing additional work orders within the contract.

Obfuscated bribing via career setup

Participant's motivation to effect requirements as mentioned above can be increased by agreeing placement of employment to tenderer or tenderer's close circle in the participant's organisation after tendering of the contract. In addition to tenderers, also personnel preparing the tendering are known to benefit from obfuscated bribing.

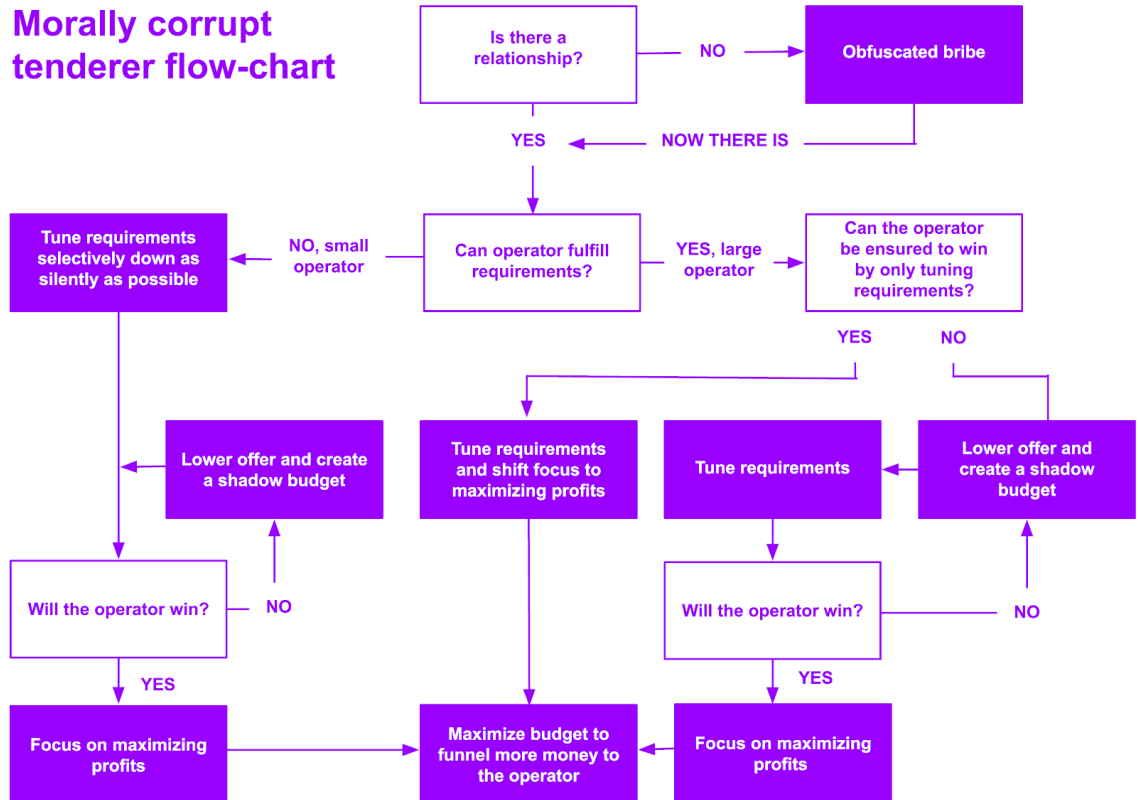


Diagram 1. Morally corrupt tenderer flow-chart

Methods to recognize individual projects with corrupt tendering.

Requirement manipulation.

Artificially high requirements. Artificially high requirements function as a gatekeeper against unfavorable operators. Thus, they result in a reduced number of operators taking part in the tendering.

An individual project can be flagged if the ratio between the number of operators participating in the tendering and the median of the number of operators participating in the tenderings in the sector is sufficiently small.

The following data must be acquired for all projects to be investigated:

- Number of operators participating (that fulfill the requirements)

- A comprehensive dataset of the operators participating in tenderings for the sector. If possible, this dataset should be as large as possible and of projects that are as “clean” as possible.
- Project, operator, and tenderer identification.

Artificially low and specific requirements tailored for a given “small operator”. The purpose of this is to sneak in a favored small operator who would not otherwise pass the requirements. To accomplish this without opening a door to other small operators, the changes in the requirements should happen just before the tendering starts so that the other small operators may not notice or have insufficient time to prepare their offer.

An individual project can be flagged if the tendering requirements are detected to have been changed an abnormally short time before the tendering (comparison to median). In the case of the tenderer obfuscating the requirement change, keeping track of the operators that have won the tendering and whether they fulfill the open requirements, although the data can be complicated to achieve.

For this the following data must be acquired for all projects to be investigated:

- Change dates of the project requirements (former)
- Time window of the tendering (former)
- A comprehensive dataset of the tendering change dates and time windows for the sector. If possible, this dataset should be as large as possible and of projects that are as “clean” as possible. (former)
- Requirement metrics (latter)
- Operator metrics (latter)
- Project, operator, and tenderer identification.

Budget manipulation and additional work

Abnormally large budget and low winning offer may indicate corruption. The purpose of an abnormally high budget for additional work is to funnel money to an operator who will be known to win the tendering by lowest price. This can be analyzed by studying the ratio between budget for additional work and the project budget with respect to the median ratio between budget for additional

work and the project budget in the sector. Abnormally high ratio can be a flag in itself, but also in conjunction with the former analysis.

For this the following data must be acquired for all projects to be investigated:

- Budgets of the additional work and project itself.
- A comprehensive dataset of both aforementioned budgets for the given sector. If possible, this dataset should be as large as possible and of projects that are as “clean” as possible.
- Project, operator, and tenderer identification.

Obfuscated bribing via career setup

Obfuscated bribing via career setup. Obfuscated bribing via career setup is related to the motivation of the person within the organization carrying out the tendering process by promising a lucrative career within a company participating in the tendering process if the company wins it.

For this the following data must be acquired for all projects to be investigated:

- Data of all hires for companies that have ever participated in public tendering.
- Historical database of all public servants that have ever held positions of authority in public tendering processes.
- Historical database of all public tendering projects.

General public competition health metrics

- Number of tendering participants for public tenderings for given public entities
- Number of tendering participants for public tenderings for given sectors
- Number of tendering participants for public tenderings for given operators
- Periodical (yearly) medians of additional work budget to project budget ratios for given public entities
- Periodical (yearly) medians of additional work budget to project budget ratios for given sectors

- Periodical (yearly) medians of additional work budget to project budget ratios for given operators

Mathematical methods used in the proposed investigation(s):

The metrics discussed above can vary wildly between tendering processes and projects. Thus, most of the proposed methods rely on comparing these values with a typical value, and flagging projects or tendering processes with atypical or anomalous values for further investigation. In order to achieve this:

1. A typical value must be established, i.e., what is considered the expected baseline, and
2. Threshold of anomaly must be established, i.e., how large of a difference with respect to a typical value is required to consider the value anomalous.

Both of the above have to be established for all of the studied metrics. Given both the expected diversity and current unavailability of data, the rest of the section focuses on providing a framework and outlining important considerations for suggested future analysis and research.

Typical value

Typical value denotes a “center” of the dataset, and common ways of acquiring the center of a dataset include median, mode and various types of means, i.e., the arithmetic mean, the geometric mean and the harmonic mean. [20] [21] [22]

The median

The median of a set denotes the centermost element of the set (if the set has an odd number of elements) when the set is ordered from the smallest element to the largest element, or the average of the two centermost elements (if the set has even number of elements) when the set is ordered from the smallest element to the largest element.

More formally, the median \bar{x}_M of a dataset $X = \{x_i\}$ with a number of elements N is defined as follows:

Define an ordered set $Y = \{y_i\}$ that contains all elements of X exactly once and where the elements are ordered from the smallest to the largest, i.e., if $i < j$, then $y_i \leq y_j$ for all i and j . Now the median can be written as. [20]

$$\bar{x}_M = \begin{cases} y_{(N+1)/2} & \text{if } N \text{ is odd} \\ \frac{1}{2}(y_{N/2} + y_{(N+1)/2}) & \text{if } N \text{ is even} \end{cases}$$

While the median is a less precise estimate of the center than for example the arithmetic mean for unskewed and otherwise well-behaving distributions, it is more resilient to extreme outliers. Thus, it can be expected to serve well as an estimation of a baseline estimated from data that likely contains anomalous outliers in itself for an analysis whose purpose is to determine the very anomalous outliers.

The mode

The mode of a set denotes the most common value present within the elements of the set. In addition to its simplicity, the mode serves as a good measure of center for cases where the elements are not numerical (and thus cannot be ordered or averaged) and where the set is defined in multiple dimensions where for example the median cannot be determined. However, in order for the mode to be useful, the set must be sufficiently discretized so that multiple instances of the same values exist. Further, the mode only takes into account the “highest peak” of the distribution, greatly limiting its usefulness for data that consists of multiple separate peaks. For these reasons, the mode is not expected to function well in the suggested analysis.

The means

The mean is a common measure of center based on the expected type of relationship between the elements or values of the studied set or the underlying distribution, respectively. Depending on this relationship, different types of mean are used, such as

the arithmetic mean (additive relationship, linear values), the geometric mean (multiplicative relationship, exponential values) and the harmonic mean (reciprocal relationship, values are rates or ratios).

The arithmetic mean of a set is calculated by summing the elements together and dividing the result by the number of elements. More formally, the arithmetic mean \bar{x}_A of a dataset $X = \{x_i\}$ with a number of elements N is defined as [22]

$$\bar{x}_A = \frac{1}{N} \sum_{i=1}^N x_i .$$

The geometric mean of a set with N elements is calculated by multiplying the elements together and taking a N:th root of the result. More formally, the geometric mean \bar{x}_G of a dataset $X = \{x_i\}$ with a number of elements N is defined as. [22]

$$\bar{x}_G = \sqrt[N]{\prod_{i=1}^N x_i} .$$

The harmonic mean of a set is calculated by summing the reciprocals of the elements together, taking the reciprocal of the result, and multiplying it with the number of elements. More formally, the harmonic mean \bar{x}_H of a dataset $X = \{x_i\}$ with a number of elements N is defined as [22]

$$\bar{x}_H = \frac{N}{\sum_{i=1}^N (1/x_i)} .$$

The different types of means give different measures of center, and the choice between them depends on the nature of the studied datasets and their underlying distributions. Without more detailed information about the underlying mechanics, most of the metrics whose centers are studied here are assumed to be additive in nature, and thus the arithmetic mean would be the most logical first choice between the means. However, studies of the ratios between the additional work budget and total budget can be considered as ratios. Thus, for those metrics, the harmonic mean may give the best baseline estimate. None of the proposed metrics are expected to be multiplicative in nature.

To summarize, the best measures of center to be used for the acquisition of the typical value, are expected to be either the median or the arithmetic mean. The selection between these two depends on the effect of extreme outliers to the measure and the general shapes of the distributions. For the ratio between the additional work budget and total budget the harmonic mean should also be considered, as distribution's behavior may more closely represent that of a reciprocal system.

Threshold of anomaly

The threshold of anomaly represents the threshold upon which the difference between the observed value and the typical value is high enough to be considered anomalous, warranting additional investigation. The optimal value of the threshold of anomaly is expected to depend on the studied metric itself as well as a variety of other factors, and thus, it should be determined experimentally in the end. However, certain guidelines can still be established, and in this section a basic framework and relevant considerations for the selection process are proposed.

From a practical perspective, the threshold of anomaly is considered in order to optimize the efficiency and the accuracy of the investigation. The efficiency is related to false positives, i.e., how often a legitimate case is flagged as suspicious (wasting the resources of the investigator). The accuracy is related to false negatives, i.e., how often an illegitimate case is not flagged as suspicious (making the analysis ineffective). Clearly, optimizing either of the two alone by setting the threshold of anomaly as an extremely low or high number causes the other two to be horribly suboptimal. Thus, a further research on the subject is required.

It is evident that the optimal point of the threshold of anomaly depends on the amount of random spread of the legitimate data around its typical value. Typical measures for

the amount of spread in a distribution are variance and standard deviation. The variance is calculated by calculating the square of the difference between the data point and the typical value for the all data points in the dataset, adding them together, and dividing the result with the number of data points. More formally, the variance σ^2 of a dataset $X = \{x_i\}$ with a number of elements N and a typical value of \tilde{x} is defined as.

$$\sigma^2 = \frac{1}{N} \sum_{i=1}^N (x_i - \tilde{x})^2 .$$

The standard deviation is the square root of variance defined as

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \tilde{x})^2} .$$

It should be noted that here typical value is used instead of mean since it is considered the most representative value of the center of the dataset. Thus, depending on the case, the typical value \tilde{x} may be equal to the median \bar{x}_M , the arithmetic mean \bar{x}_A or the harmonic mean \bar{x}_H . In addition, terms variance and standard deviation are used interchangeably with their sample counterparts. While this approximation introduces downward bias [23], these estimates are used here just as a normalization tool for the proposed threshold function templates. This lack of formality is justified by the fact that due to the lack of data the mathematical analysis of this work is but a set of guidelines to be used in the suggested investigation algorithms that are expected to be highly phenomenological by practical necessity.

Between the variance and standard deviation, standard deviation is mainly used in the following as a spread parameter for the proposed types of threshold functions. This is because the standard deviation retains the units of the data type. This results in more intuitive values when tuning the functions as well as, enables more convenient normalization. In addition, it may be practically useful to use asymmetric threshold

functions which would be more difficult to normalize using variance. Other potential measures to consider include for example mean deviations.

Threshold functions

The threshold function templates are designed so that they provide a set of tools to approach the optimization problem of setting a flagging algorithm for suspicious tendering. The functions include an explicit tuning parameter α (here, a single tuning parameter is included, but the functions could be easily generalized to have multiple tuning parameter) that is used for the optimization. The other arguments are the typical value \tilde{x} and the standard deviation σ discussed above, as well as the data point to be investigated x . Thus, the functions can be generally written as,

$$f(\alpha; \tilde{x}, \sigma; x),$$

where the different types of arguments are separated for clarity; the tuning parameter α , the comparison dataset parameters \tilde{x} and σ , and finally the data point variable x .

The most intuitive way to implement the typical value and measure of spread is to simply compare the data point deviation from the typical value and normalize that using the standard deviation. Further, the simplest way to introduce the tuning parameter is to apply it just as a tuning factor. Lastly, as the purpose of the threshold function is to either flag or not flag data points, its codomain should be $\{0,1\}$, a step function should be applied. This yields the simplest template of a threshold function,

$$f_+(\alpha; \tilde{x}, \sigma; x) = f\left(\alpha; \frac{x - \tilde{x}}{\sigma}\right) = H\left(\alpha \frac{x - \tilde{x}}{\sigma} - 1\right),$$

where $H(x)$ is the Heaviside step function.

$$H(x) = \begin{cases} 0, & \text{if } x < 0 \\ 1, & \text{if } x \geq 0 \end{cases}.$$

The above function is asymmetric, and only flags large anomalies, i.e., where the data point is too large (hence the subscript +). For detecting only small (-) anomalies, i.e., where the data point is too small, the function can be rewritten as

$$f_{-}(\alpha; \tilde{x}, \sigma; x) = f\left(\alpha; \frac{\tilde{x} - x}{\sigma}\right) = H\left(\alpha \frac{\tilde{x} - x}{\sigma} - 1\right).$$

Lastly, for symmetric (S) detection, i.e., where the data point is either too small or too large, the function can be rewritten as

$$f_{s}(\alpha; \tilde{x}, \sigma; x) = f\left(\alpha; \frac{|\tilde{x} - x|}{\sigma}\right) = H\left(\alpha \frac{|\tilde{x} - x|}{\sigma} - 1\right)$$

or, alternatively,

$$f_{s2}(\alpha; \tilde{x}, \sigma; x) = f\left(\alpha; \frac{(\tilde{x} - x)^2}{\sigma^2}\right) = H\left(\alpha \frac{(\tilde{x} - x)^2}{\sigma^2} - 1\right),$$

utilizing variance. There are of course multiple ways to threshold the results – including considerably more sophisticated ones – but without further information about the properties of the distributions in question or real data, discussing their merits would be mere speculation and unproductive from the perspective of the scope of this work. Thus, these simple functions serve as the basis of the proposed approach.

Combined threshold functions

The aforementioned threshold functions are all binary, i.e., they will always result in either yes or no in terms of if a data point is sufficiently anomalous and thus suspicious. However, in practice, there may be additional information that needs to be taken into account for a case. Indeed, multiple corruption indicators discussed in this work could be studied simultaneously to improve detection of a corruption instance where multiple

indicators are simultaneously relevant. Binary functions do not serve well for this purpose.

A potential solution is to alter the individual threshold functions by switching the Heaviside step function into a continuous function that produces values between one and zero, representing probabilities. These probabilities could then be combined and only then subjected to a Heaviside step function, effectively moving the threshold outside the individual “threshold functions,” hereafter referred as analysis functions. As an example, the Heaviside function could be replaced with a function,

$$g(x) = \begin{cases} 0, & x < -\frac{1}{2} \\ x + \frac{1}{2}, & -\frac{1}{2} \leq x \leq \frac{1}{2} \\ 1, & x > \frac{1}{2} \end{cases}$$

yielding an analysis function

$$f(\alpha; y) = g(\alpha y - 1),$$

where y depends on the detection type (see above). The threshold can then be calculated from the values of the individual analysis functions for example by taking a geometric mean and thresholding that with a Heaviside function

$$F = H(\alpha_c \bar{f}_G - 1),$$

where F is the combined (binary) threshold function, α_c is a tuning parameter for the combined thresholding, and \bar{f}_G is the geometric average of the individual analysis functions.

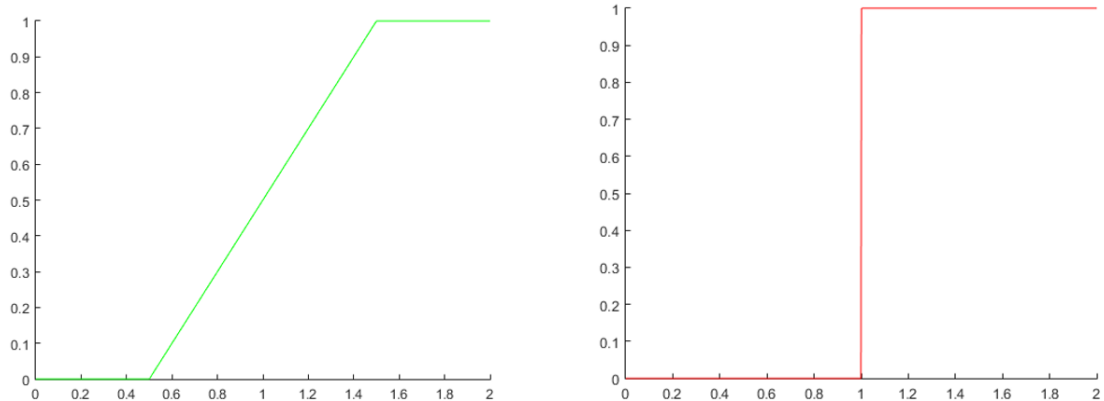


Figure X. Left: $g(\alpha y - 1)$ versus αy . Right: $H(\alpha y - 1)$ versus αy .

There are of course multiple ways of combining individual analysis functions results – including considerably more sophisticated ones – but without further information about the properties of the distributions in question or real data, discussing their merits would be mere speculation and unproductive from the perspective of the scope of this work.

Multi-point samples

The above analysis has been carried out for a single data point, i.e., a measure from a single tendering instance. Although this is useful for flagging singular events for further investigation, it is also possible to utilize the above methods for portions of the data with respect to the entire datasets. This can be utilized to study long-term trends as well as potential correlations with certain sectors, operators or public entities. This can be done with or without threshold functions. The latter provides statistics to be analyzed by humans. The former enables alert mechanisms with respect to time-evolutions of the statistics, potentially with respect to different sectors, operators and public entities. To utilize threshold- and analysis functions in this manner, the data point variable x can be simply replaced with an average value (or some other measure of center) over the sample.

6. DISCUSSION

6.1. Discussion of results

Research was conducted with a combination of PESTEL strategic analysis tool and literature review. During the literature review, each PESTEL category perspective was investigated and relevant research questions were set for analysing the institutional corruption phenomenon in public procurement.

Firstly, political will was investigated by literature review to Finnish legislation and specifically legislation concerning the target institute. Target institute's mission was investigated for determining the purpose of the organisation. Target institute was set to Finnish Transportation Agency, its main purpose is to maintain and develop Finnish transportation infrastructure. Institute's annual budget is approximately two billion euros.

Secondly, economical evaluation of the target institute's methodologies on surveillance of public procurement methods within their organisation was investigated. Target institute did not perform any economical incentive analysis on their economical environment and stakeholder analysis of economic incentives was absent.

Thirdly, social effects of public procurement were investigated. As no data from the target organisation was available on the subject, research was based on earlier literature review published by Ari Salminen in 2015. Review indicated that it can be concluded that institutional corruption is a relevant risk also in Finnish society. Effects of institutional corruption in public procurement poses a risk of increased cost, decreased quality and decreased public trust toward government officials.

As part of the research brief investigation on target institutes ICT-systems were also conducted. Purpose of the review was to gain understanding of which data could be implemented on surveillance of public procurement methods in target organisations. During the research it became clear that on-site data could not be related to public procurement data, as valid public procurement data was not available from the target organisation.

In addition, environmental factors are increasingly affecting public procurement requirements. During the research target institute's methodology of applying environmental requirements were investigated and the target institution did not have guidelines or established methodology on determining environmental requirements. All environmental requirements are determined on project bases, which makes data based analysis impossible and exposes environmental requirements to be used as part of institutional corruption.

Legal analysis was conducted and it gave bases for legislative analysis of the subject. Main finding was that current methodologies of surveillance in the target institute were mainly absent and according to law responsibility of such surveillance lies on government officials handling his operations. No logical surveillance methodology was applied to target institutes procurement and available quantitative data was unavailable or incomplete.

Lack of data made it impossible to test answer on primary research questions of how can corruption indicators be recognized and author established hypothesis models for recognition of corruption indicators with algorithms. Further research and testing of the hypothesis is needed for validating these models. Models were established for recognition of participation requirement manipulation, budget manipulation and extensive additional work order and so called revolving door phenomenon.

6.2. Contribution to previous research

This research contributes to the earlier research by providing hypothesis models for recognition of corruption during the public procurement process. In addition, it provides information on legislative obstacles for gaining quantitative information for further development of recognition algorithms and suggests possible changes for making needed information available.

6.3. Practical conclusions

Practical conclusions are that researchers and citizens do not have access to government procurement data on such level that they could perform their own surveillance on public procurement processes. In addition, agencies working on public

procurement do not surveil their procurements with algorithms nor are currently planning to apply such methodologies in their operations.

Finnish Publicity law does not provide sufficient duty to government agency officials for delivering the data and exceptions listed in the law effectively invalidates the main purpose stated in the law.

Agency does not implement any economical incentive evaluations in their operations. Supervision is made with low level random inspection methods and crime trapping threshold is on high level.

6.4. Critical evaluation of the research design and implementation

Structure of the research was adjusted several times from the original plan during the research process. These changes were caused by non-availability of relevant data. Major change to the structure was adding legal evaluation of data availability to the thesis and inability to test hypothesis of recognition methodologies with real dataset.

Research questions were adjusted for the purpose during the research. These questions were determined based on problems on data acquisition from government institutes and questions were planned to show weaknesses in the public procurement process and legislation. And so forth, questions in combination give a certain point of view of the problems investigated in this research.

As the author has investigated problems in public procurement methodologies on his daily operations for more than ten years, a predetermined mind-set has to be recognized as part of the critical evaluation of the research. Thus, the author's experience in the subject has given ability to investigate the problems without guidance from government officials. As it is recognized that most of the earlier research has been performed in cooperation with the target institute.

REFERENCES

- [1] Liamputtong, Pranee - Focus group methodology: Principle and practice. - Sage Publications, 2011.
- [2] ARI SALMINEN - Rakenteellinen korruptio - Kartoitus riskitekijöistä ja niiden hallinnasta Suomessa - VAASAN YLIOPISTON JULKAISUJA, SELVITYKSIÄ JA RAPORTTEJA 203, 2015
https://www.univaasa.fi/materiaali/pdf/isbn_978-952-476-619-7.pdf
- [3] YLE web-page 3.2.2021 - HUSin johtaja osallistui kilpailutuksiin, jotka voitti hänen perhetuttunsa yhtiö – MOT:n lähde: "Tämä hulluus täytyy lopettaa" -
<https://yle.fi/uutiset/3-11763290>
- [4] Finlex webpage - Ajantasainen - Laki viranomaisten toiminnan julkisuudesta - 21.1.2021
<https://www.finlex.fi/fi/laki/ajantasa/1999/19990621>
- [5] Olli I. Heimo: ICARUS, OR THE IDEA TOWARD EFFICIENT, ECONOMICAL, AND ETHICAL ACQUIREMENT OF CRITICAL GOVERNMENTAL INFORMATION SYSTEMS
- [6] Wikipedia web-page 3.2.2021 - PEST Analysis - https://en.wikipedia.org/wiki/PEST_analysis
- [7] Scanning the Environment: PESTEL Analysis,
<https://www.business-to-you.com/scanning-the-environment-pestel-analysis/>, 27.10.2019.
- [8] Gray, David E. - Doing research in the real world - Sage, 2013.
- [9] Finlex webpage - Ajantasainen - Laki Väylävirastosta -4.1.2021
<https://www.finlex.fi/fi/laki/ajantasa/2009/20090862>
- [10] Väylävirasto webpage - Strategy - 4.1.2021
<https://vayla.fi/en/operating-philosophy/vision-strategy-and-values>
- [11] Väylävirasto webpage - Code of Conduct - 4.1.2021.
<https://vayla.fi/en/operating-philosophy/vision-strategy-and-values/code-of-conduct>
- [12] Väylävirasto webpage - Operation philosophy - 4.1.2021.
<https://vayla.fi/en/about/operating-philosophy>
- [13] Eduskunta web-page 24.2.2021 - Valtion vuoden 2021 talousarvio -
https://www.eduskunta.fi/FI/naineduskuntatoimii/eduskunnan_tehtavat/talousarvio/Sivut/Budjetti-2021.aspx
- [14] Väylävirasto - Järjestelmäkuvaukset - 27.10.2020.
- [15] Email - Finnish Transportation Agency - Kruth Anu - 30.12.2020
- [16] Email - Finnish Transportation Agency - Katja Koskelainen - 19.1.2021
- [17] Väylävirasto tietopyyntöhinnasto 1.11.2019
- [18] Finlex webpage - Ajantasainen - Rikoslaki -
<https://www.finlex.fi/fi/laki/ajantasa/1889/18890039001>
- [19] Finlex Webpage 8.2.2021 - 1397/2016
 Act on Public Procurement and Concession Contracts
<https://www.finlex.fi/en/laki/kaannokset/2016/en20161397.pdf>
- [20] <https://mathworld.wolfram.com/StatisticalMedian.html>

[21] Econometrics. McGraw-Hill Irwin. 3rd edition, 2006: p. 110. probability distribution

[22] <https://www.britannica.com/science/mean>

[23] Introduction to Modern Statistical Mechanics, David Chandler, Oxford. ISBN 0-19-504277-8.