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Master's Thesis in Strategic Finance and Business Analytics

SOFTWARE ROBOT-BASED AUTOMATION OF FINANCIAL ADMINISTRATION'S PROCESSES

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Markus Renner
1st Supervisor: Mikael Collan
2nd Supervisor: Azzurra Morreale

TIIVISTELMÄ

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Tämä opinnäytetyö tutkii, miten ohjelmistorobotiikkaa voidaan hyödyntää taloushallinnon tehtävissä. Esimerkkinä ohjelmistorobotiikan hyödyntämisestä toimii suomalainen kaupunki, jonka talouspalvelukeskus on ottanut ohjelmistorobotiikan käyttöönsä ostolaskuprosessissa. Empiirinen tutkimus toteutettiin haastatteluiden avulla tehtynä case-tutkimuksena. Tarkoituksena oli selvittää, mitkä tehtävät voitiin tehokkaasti toteuttaa robotiikan avulla, millaisia muita ratkaisuja olisi mahdollista käyttää ja millaisia haasteita robotit kohtasivat sekä verrata näitä tuloksia aiempaan kirjallisuuteen.

Ohjelmistorobotiikka voi kirjallisuuden mukaan tehostaa prosessien toteutusta ja vapauttaa työvoimaa tuottavampiin tehtäviin. Ohjelmistorobotiikka onkin otettu käyttöön monissa taloushallinnon tehtävissä: mm. dokumenttien luonnissa ja tarkistuksissa sekä tiedon etsinnässä ja siirrossa. Kirjallisuuteen perustuvassa teoriaosiossa käsitellään ohjelmistorobotiikan lisäksi muita toimistotehtävien automatisointivaihtoehtoja sekä määritellään, mitkä prosessit kuuluvat taloushallintoon. Kirjallisuuden ohjelmistorobotiikkaesimerkit keskittyvät ensisijaisesti kansainvälisiin yrityksiin, kun taas case-tutkimuksen kohteena oli kotimainen julkinen organisaatio.

Tämän tutkimuksen tulosten perusteella ohjelmistorobotit soveltuvat taloushallinnon tehtäviin, kuten ostolaskuprosessiin, jossa ne suorittavat esimerkiksi ostolaskujen reititystä, tarkistusta ja tiliöintiä. Robotiikan käyttöönotto voi kuitenkin olla hidasta ja vaatia huomattavasti työntekijöiden aikaa, minkä lisäksi robotit eivät pysty käsittelemään kaikkia dokumentteja, sillä näistä osasta puuttuu robottien tarvitsemia tietoja tai tieto on rakenteeltaan poikkeavaa. Nämä poikkeavat

dokumentit vaativat yhä ihmistyöntekijän käsittelyn. Lisäksi robotit eivät kykene tekemään kaikkia prosessin vaiheita nykyisillä laatuvaatimuksilla.

Tutkimuksessa myös vertaillaan sitä, miten robotiikan käyttö kohdeyrityksessä on onnistunut verrattuna lähdekirjallisuudessa tarjottuihin esimerkkeihin. Kirjallisuus on koonnut useita toimenpiteitä, joiden avulla robotiikan käyttöönotto on onnistunut niin prosessi- kuin organisaatiotasollakin. Kohdeyritys seurasikin näitä toimenpiteitä monilta osin, mikä vahvistaa, että kirjallisuuden löydökset soveltuvat uusiin tapauksiin. Näiden toimenpiteiden seuraaminen voi helpottaa suunnittelemaan ohjelmistorobotiikan käyttöönottoa ja arvioimaan robotiikan kannattavuutta.

ABSTRACT

Author: Markus Michael Renner

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This thesis discusses how robotic process automation can be utilised in financial administration. A Finnish city that has implemented robots into the accounts payable process in its shared services centre has been used as an example. The case organisation is public and highly domestic compared to previous cases scrutinising robot process automation (RPA). Case study methodology is used in this thesis. The aim of this research is to scrutinise which tasks can be effectively executed with RPA, what challenges RPA has faced, when is it more suitable to use other solutions, and compare findings from case organisation to previous literature.

Literature suggests robotic process automation may provide competitive advantages and free up labour for more productive tasks. RPA has already been implemented into several tasks in financial administration for example in invoice creation, checking, and transfers between software. In addition to RPA, the theory section expands on other office automation solutions and defines financial administration's processes.

Results of the thesis suggest that RPA can be successfully implemented into financial administration processes like accounts payable, but implementation can be time consuming. Invoices do not always follow one standard and may lack important data, robots can't accurately scan and input invoices correctly. These exceptions have to be handled by human labour. Moreover, RPA is not capable to automate all tasks with current process quality requirements.

This thesis also provides a comparison between RPA cases in literature and the case study. Literature has argued for several success factors in implementing and utilising RPA which case

city has also followed in many respects. Findings from the case support previous findings. These success factors, in addition to findings from the municipality's case, may help future adopters of RPA to evaluate how the implementation should be executed and under which circumstances software robot-based automation is most likely profitable.

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1. Introduction

Financial administration is an operation that is part of every enterprise's and organisation's activity. Financial administration is a process consisting of monitoring, reporting and analysing organisation's financial performance (Lahti & Salminen 2014, 16-21; Atrill & McLaney 2006, 2). It ranges from statutory accounting to otherwise compulsory invoice handling and to reporting, cash management, archiving and controlling (Lahti & Salminen 2014, 16-18; Everaert, Sarens and Rommel 2008, 93-95; Asatiani 2016, 43). Departments in charge of financial administration processes have traditionally required a huge amount of manual labour to complete these processes which is time consuming and therefore expensive. Indeed, in Finland the accounting agency business has a revenue of nearly one billion euros and a large city can spend dozens of millions to its financial shared services alone (Taloushallintoliitto 2018; Helsinki 2017, 124,239). When electronic invoices and purchase orders are not used, even more time is required to handle invoices. A lot of manual labour is needed, because all invoices must be authorized, and the receipts have to be entered into a proper software for accounting, payment, and other purposes. Human-made errors can occur too and there may be variance in information that is being entered into accounting, or enterprise resource planning software.

Financial administration's processes like the previously mentioned invoicing and accounting processes comprise of several tasks, such as creating new accounts and transforming data from one location to another within or between different software. When these tasks have repetitive and rule-based elements, information technology (IT)-driven deep-layer software changes can be implemented to automate them. In this thesis, as well as in the literature, these automation solutions, using deeper layers of systems than user interface and require software changes, are called "heavyweight IT" or back-end system automation. While these solutions can be profitable, especially when volume is very high, they are costly and often slow to implement. (Penttinen, Kasslin & Asatiani 2018, 1-11; Lacity, Willcocks & Craig 2016, 22-27; Slaby & Fersht 2012, 4-5).

Another automation solution to bolster effectiveness is software robot-based automation (commonly referred to as robotic process automation and simply RPA). Even though commonly called ones, these software robots are not actual robots but software licences capable of different functions in user interface of different programs (Lacity, Willcocks & Craig 2016, 21-22). For clarity's sake, this thesis will refer to these licences as robots as is done in the literature. In robotic process automation, a robot mimics human performance and uses the same methods as human does: namely keyboard and mouse commands (Lacity & Willcocks 2015). Per Lacity, Willcocks & Craig (2015a, 5-6) and Zarkadakis et al. (2016), RPA is very well suited for processes where input system and system of record are different systems. They refer to these processes as "swivel chair" processes. Unlike the "heavy" back-end solutions, RPA only interferes with user interface just like humans and does not require changes to software it uses. (Lacity et al. 2015a, 6-9; Slaby & Fersht 2012, 5). Software robots can only execute tasks configured at the editor window. This configuration can be executed by a human who creates a suitable flowchart. (Lacity et al. 2016, 23; Hodson 2015; Lacity & Willcocks 2015). However, Moffitt, Rozario & Vasarhelyi (2018, 2) add that many editors have a record button which means that manual creation of flowchart is not required but the editor creates this flowchart by following how a task is done.

RPA has been found to outperform both human employees and heavyweight IT solutions in certain cases and can therefore be considered a potent solution (Lacity et al. 2016, 25-29; Slaby & Fersht 2012, 10-11; Penttinen et al. 2018, 5-11). RPA itself is not always an alternative but a complement to existing solutions such as heavyweight business process automation mentioned previously (Lacity et. 2015a, 6-8). The market growth of RPA tells about its growing popularity: Toivonen (2016) mentions RPA markets to have been two billion euros 2016 and PR Newswire claims the markets will exceed five billion USD by 2022 (PR Newswire 2017).

Davenport & Kirby (2016, 22-23) consider robotic process automation a category of cognitive technologies, but not capable of context awareness or learning like machine learning (ML) or neural networks. Indeed, they further elaborate that RPA performs digital tasks that are repetitive and/or can support human but requires set rules unlike other, learning capable cognitive solutions: sign analysing, number analysing and robots performing physical tasks. Division into different cognitive technologies by Davenport & Kirby is presented in table 1. Digital tasks' automation as a non-learning cognitive technology is disputed by Zarkadakis, Jesuthasan & Malcolm (2016) who consider cognitive automation capable of utilising machine learning but also robotics in the form of chatbots and like. Both Boulton (2017), Zarkadakis et al. (2016) and Del Rowe (2017) suggest that RPA will be more incorporated into artificial intelligence (AI) and machine learning in the future whereas Hodson (2015) exhibits RPA as AI solution.

Table 1. Cognitive technologies per Davenport & Kirby (2016, 24) and Zarkadakis et al. (2016).

Task type	Support for human labourers	Most advanced method	Configuration (set rules/learning)
Analysing numbers	Business Intelligence, data visualisation	Machine learning, neural networks	Learning
Analysing text & pictures	Character and speech recognition	IBM Watson, language interpretation	Learning
Executing digital tasks	Business process management	RPA, BPM / **cognitive automation**	Set rules / **Learning**
Executing physical tasks	Remote operating	Autonomous robots	Learning

The previous paragraph discussed artificial intelligence's relationship with RPA. The artificial intelligence is defined as intelligent behaviour of machines (Ertel 2011, 1; Hutter & Legg 2007, 405). Hutter & Legg (2007, 405) define machine intelligence to be approximately agent's capability to interact with different environments and achieve its goals. Ertel (2011, v) includes agents, logic, search, reasoning in the presence of uncertainty, neural networks and machine learning as part of AI. He mentions agent to be "*a system that processes information and produces an output from input*" and that several types of these robots are defined in literature. An example would be a software agent, a program using user input to calculate a result, or hardware agent which affects its environment based on perception from the respective environment: e.g. filtering mail into spam and useful. (Ertel 2011, 9-12). Therefore, RPA software robots could also be called software agents. Arguably, an advancement of these agents is a learning agent that can change its performance based on further instructions (Ertel 2011, 11-12). As Ertel (2011, v) mentioned, machine learning is part of the AI too. It means the capability of a machine to learn things not explicitly taught to it by a human user, i.e. learning without direct programming. It can be considered an extension of automation. Another way to express what machine learning is, is that in traditional programming computer is used to produce output with data and program. However, in machine learning computer produces a program using data and the output. (József Mezei 2016, 18-19). Del Rowe (2017) cited that machine learning and software robots can be combined. Even when RPA itself does not use machine learning, another automation solution does. It is called cognitive automation and it is better explained in chapter “Alternatives of RPA” (Zarkadakis et al. 2016). As Automation Anywhere company advertises, cognitive automation may not be an actual alternative to RPA but a tool that utilises both of them (Automation Anywhere 2018).

1.1. Focus of this research

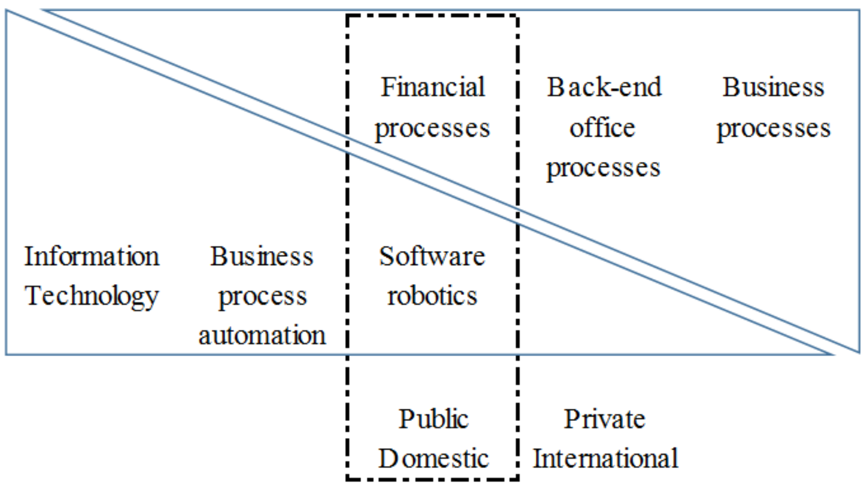
The focus of this research is in the intersection of information technology sciences and financial management. Inside information technology, the focus is in business process automation, especially in financial management’s processes. The main solution to be scrutinised for automating financial management processes is robotic process automation which is compared to other automation solutions within business process automation. The intersection area is financial administration’s automation with RPA. Focus is summarised in figure 1 below. The relationship of IT solutions with each other and with financial processes is presented in figure 2. The research will also focus into public rather than private sector and domestic rather than international when such division is necessary. The case organisation is a specimen of public and domestic organisation. The focus within financial management is in defining its processes, and tasks inside these processes, and how automatable they are.

The research will in each chapter move from wider topic to narrower one. The first theoretical chapter handles the widest topic, financial administration, then the second theoretical chapter concentrates on automation of financial administration and the third covers only one automation method: robotic process automation. The following chapter is the case study and focuses on utilising RPA in a single organisation’s financial administration.

Currently, studies regarding RPA’s implementation to financial administration processes exist. For example, Moffitt et al. (2018) discuss implementing RPA into auditing, Slaby & Fersht (2012) mention ledger automation with robotics, Lintukangas’ (2017) thesis has handled RPA’s potential in indirect procurement process and both Lacity & Willcocks (2015a) and Hodson (2015) refer to financial administration related tasks been automated. However, none of them focus entirely on financial administration nor do they include public organisation’s perspective. Finnish public organisation may well differ from English-speaking one and from international company:

potentially outsourced documents are in Finnish and purchases vastly exceed sales. Because the case organisation is public and domestic, this research will try to broaden the knowledge from such organisation's viewpoints. Therefore, third aspect for focus is domestic public organisation compared to international and private ones more common in the literature. Other software robot solutions like robot following prices in internet and robot filling information into news articles are out of this thesis' focus.

Figure 1. Sciences this thesis focuses on and focus within them.



This study will gather together previous findings regarding RPA's implementation and utilisation. Thus, any financial administration organisation planning to implement RPA, expand its use or evaluate its performance may benefit from this research. As mentioned in previous chapter, financial administration can be a significant expense to many organisations and these organisations should consider whether robots have potential to reduce these expenses.

Figure 2 will summarise where robots work and an example what they can do. The top row presents financial processes/tasks either a human or a robot can conduct with an example in brackets (modified after KPMG 2017; Lacity et al. 2015a, 1-6). Per Lacity et al. (2015a; 2016), Zarkadakis et al. (2016) and Penttinen et al. (2018), these tasks can include at least moving, filling and checking data. Orange ellipses represent possibilities of human work force in the left and configuration alternatives for RPA applied from Moffitt et al. (2018, 1-3) and Boulton (2017) in the right. Machine learning and other AI are emerging solutions for configuration (Boulton, 2017;

Zarkadakis et al. 2016). BPM, business process management, stands as an alternative of RPA. Its configuration methods are in green and done by IT staff.

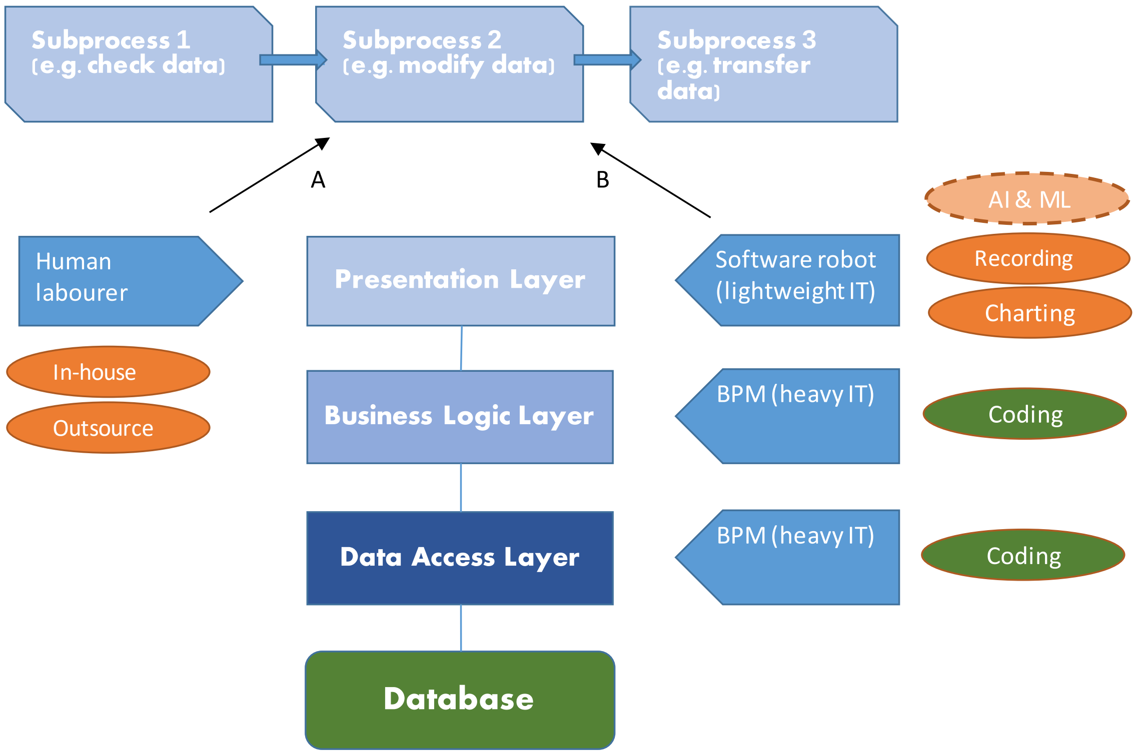


Figure 2. Subprocesses, "tasks", of accounts payable process. Different layers of a system and where different agents work (Lacity et al. 2015a, 7-8).

This thesis will explain what robotic process automation is from business process point of view utilising current literature and empirical interviews. Inside business processes, focus is on defining processes in financial administration and are these processes performed most effectively with RPA in Vantaa's financial shared services centre. Technical background of RPA is not discussed as this is business and not engineering related thesis. Financial administration and its processes are defined in chapter 2. Accounts payable process will be scrutinised more thoroughly than the rest of financial administration processes. This is due to it being the process where case organisation has implemented RPA but also because it is likely on of the most expensive processes (Lahti & Salminen 2014, 52-53; Espoo 2018, 74). However, theoretical sources and results (especially "Future prospects: implementation to new processes" and "Avenues for further research" subchapters) also focus on processes other than just accounts payable so the research is not limited to purchase invoicing. Even though results of this thesis will be related to robotic automation's performance in field of financial administration, RPA's usage in other office fields are discussed too to provide comparison between them. Alternatives for robotic process automation are not limited to any certain solution but include all solutions that can per literature perform financial administration processes. Most commonly referred alternatives are earlier mentioned heavyweight IT solutions and offshore outsourcing of employees (Slaby & Fersht 2012, Asatiani & Penttinen 2016, Lacity et al. 2016).

1.2. Research questions

The aim of this thesis is to find out how to utilise robotic process automation in financial administration's processes. This research is carried out with existing theoretical literature and empirical findings from case organisation. Another goal of this thesis is to compare the software robot project in case organisation and in literature as this will help case company to estimate whether they can consider their project successful and more importantly, what kind of changes could benefit the project. To fulfill these aims, research questions are formulated and then answered. The first research question is:

1. "How and when RPA is a suitable method to improve financial administration's processes"

To answer this question, sub-questions are formed. "When" means that under which circumstances the project can succeed. This includes what kind of tasks are suitable for this type of automation.

Moreover, it is important to know whether RPA is absolutely, not just relatively best solution for certain processes. This requires that it is compared to other solutions available. Therefore, sub-question 1a) is:

1a) "Into which tasks RPA has been successfully implemented in financial administration and can it be considered the best method to execute these tasks"

"How" requires that there are methods making RPA practical. Such methods could also be called success factors and following them increases the likelihood of the whole project becoming successful. Sub-question 1b) is:

1b) "What success factors for RPA have been found by the literature"

The best measure to evaluate the suitability of a solution is profitability. This applies to whether RPA should be used to automate financial processes or not, too. Profitability can be measured with ROI, payback period and for any new process to be implemented, break-even analysis. How is better question than yes or no because it gives more precise answer. Based on this, sub-question 1c) is:

1c) "How profitable has RPA been for its implementers?

Profitability is affected by many variables and therefore this sub-question is analysed by thinking what kinds of costs RPA has, what kinds of costs it can reduce and what kinds of challenges RPA can face. It is also compared is RPA absolutely (i.e. most profitable of all solutions) or relatively (i.e. covers costs) profitable.

Finally, to compare RPA in financial administration and in other processes, sub-question 1d) is formed:

1d) "Is financial administration a suitable target for robotic process automation"

If financial administration is less suitable than some other business fields, one can try to focus more on other business fields when considering implementation of RPA. Researching software robotics in different business fields could be considered important since business professionals, rather than IT professionals, have commonly taken the biggest role in implementation of the software robots (Slaby & Fersht 2012, 5; Lacity et al. 2016; 24-29).

Since this is a case study, it is important to find out whether the case organisation has been successful. This is done by comparing case to literature. This examination requires a second

research question:
2. “Has Vantaa been able to utilise robotics in a way literature suggests”

This question is answered with sub-questions resembling the ones in research question 1.
2a) “Into which tasks has Vantaa successfully implemented RPA and have they been the same tasks the literature mentions”
2b) “Has Vantaa been able to follow the success factors”
2c) “Has RPA been equally profitable in Vantaa and in literature”

Answering all these questions requires good measurement units. Indeed, variables leading to profitability, or the lack of it, were shortly mentioned, but there are others to think about too: such as accuracy of robot, does it increase employee satisfaction, implementation time and flexibility. Also thinking what kinds of problems occurred in implementing robotic processes should help to understand how RPA’s profitability could be further improved. These questions require deep analysis of a certain case and are therefore qualitative. In analysis part, suitable indicators are chosen to compare RPA with other solutions and to compare Vantaa’s case with literature’s cases. These are discussed more in later chapters. Should it have been applicable, return on investment (ROI) would have been calculated for the case organisation’s project and then compared to ROIs from literature, but lack of financial information, as well as the stage of the project, made such estimates too speculative.

1.3. Methodology

Because the research questions are more type “how” and “why” rather than hypotheses, this research is qualitative. Indeed, qualitative methods are more suitable because quantitative methods would require large amount of observations, i.e. RPA examples, contemporarily unavailable and would be less in-debt and impractical for case study. Vilko (2016, 10) has listed quantitative aims and they are rather fitting for the aim of this research that was discussed in previous subchapters:
“- To gain insights and new knowledge.
- To increase understanding of an interesting issue.
- *To understand phenomena which we do not have good working models and practices yet.”*

Should this thesis have been quantitative, a hypothesis could be “robot is more cost-effective than the previous (more labor-intensive) solution” or “RPA is easier, faster and/or more affordable than other automation solutions” or “based on x amount of observations, RPA increases profitable by y%”.

To receive answers for research questions, deep knowledge of RPA’s capabilities and financial administration’s processes are required. Interview of a professional in both subjects is considered the most suitable method to achieve this goal. Interview is a typical approach for qualitative research. Indeed, qualitative research tends to emphasise in-depth data which is needed to answer the research question. Qualitative research has other characteristics that fit the aims of research question 2: it does not aim to produce generalisable results and it is suitable for case studies. Moreover, aim-setting, data collection, analysis and interpretation can intertwine. (Vilko 2016, 5-9). Vilko (2016, 10) divides qualitative questions to why-type and what-type. This thesis’ questions are closer to the latter. Research question 1 (RQ1) is mainly answered with knowledge arising from literature. As there are several literature sources, saturation can be used to find out whether new articles add more information, or do they verify the findings made from previous sources. This is most suitable for RQ1 because then it can be found out whether different literature sources have come to same conclusions and new sources would not add any more information but would just repeat the findings already made (e.g. robots are not found to be used in any new tasks but new cases use them in same tasks as previous cases have already listed). For 1c quantitative research with as many observation units as possible would of course yield the most accurate profit figure, but without right explanatory variables, given such exist, the underlying reason for these figures would remain unknown.

Due to research being non-quantitative, less variables and statistics are required. However, some tables will be used to describe and compare options with labour-oriented and robot-oriented office and to sum up findings. Figures will include process maps, e.g. how robot functions and what kind of processes financial administration has. Moreover, if break-even analysis can be executed, then used variables would be cost of manual labour for a process and cost of robot for the same process. Different processes, e.g. handling an invoice or copying data from ERP to Excel, have different prices for labour and for robot use. One should also note that robot’s costs are above all fixed whereas human’s costs are variable costs.

This thesis utilises a wide amount of previous literature covering financial processes and its automation solutions which were in the focus of this research. Theory section, i.e. chapters two and three, are entirely based on existing literature. The literature includes books, articles, web pages and previous results of theses. They not only explain the already-made findings in financial processes and solutions to improve these processes but also work as a comparison for empirical findings from the case. Theoretical background is divided into three parts. Part one is financial administration, which includes the processes that are meant to be improved, and parts two and three are RPA and other automation solutions which are the methods for this improvement. More precise contents of these parts are mentioned in subchapter "Structure of this thesis". The researchers whose studies have been commonly cited are handled at the beginning of relevant theoretical chapter. Some writers have written several books and papers. Most references are from this decade and all others from this millennium.

Literature was searched from Finna, Doria, Google Scholar, Pubsonline and ScienceDirect in addition to internet search. Some texts utilised were not peer reviewed, despite efforts to choose solely them, which may reduce the reliability of this thesis. Non-peer reviewed articles are from London School of Economics and Political Science's papers, Horses for Sources, New Scientist and Harvard Business Review. The third one is listed in ScienceDirect journals and the fourth in "50 Journals used in FT Research" rank. Some non-scientific webpages (e.g. XML's own webpage) are used to some extent. Previous master theses' results are cited too for comparison. They are monitored and accepted by supervising doctors which should make them scientifically reliable.

Based on search with lines "RPA" and "Robotic process automation" in Doria, rather few final works related to robotic process automation in office environment are made but they have become increasingly common in recent years. As of summer 2018, there is one thesis from 2017 and three bachelor level studies from 2018. Additionally, some theses related to digitalisation/automation of financial processes are made. Not all theses and dissertations made in Finland are present in Doria, so search didn't provide nationwide information on RPA final work frequency.

Primary data consists of interviews with Vantaa's robotic expert and head of accounts payable team. The robotics expert coordinates the implementation of robotic process automation in city's financial shared services centre. She has been part of the project during its entirety and has worked in Vantaa in respective task for a year. Head of accounts payable team has also taken part in the robotics project the whole time. Some data is received from Vantaa's ERP software and internal reports. In addition, own knowledge gained from working in Vantaa is also utilised.

The interviews explain what kind of tasks robots can conduct, what problems they have faced and has the project been successful per respective unit. Interview questions are formulated based on literature so that each question could be answered with literature too. Furthermore, the interviews give background information on financial administration and especially accounts payable handling in respective city. The interview itself does not provide ready answers to research questions but they are answered utilising both the empirical interviews and relevant theoretical literature. Reliability and validity of the case study is handled in "Reliability and validity of the case study" chapter

In case and conclusions, methods used to conduct profitability analysis for RPA implementation are break-even analysis and payback period. The traditional break-even analysis' formula is fixed costs divided by subtraction of sales revenue per unit and variable cost per unit (Atrill & McLaney 2006, 225). This formula would offer insight for accounting company planning to implement RPA. As financial administration is a support activity in target city, and produces no profit, a customized formula should be used. Namely: variable costs x units + fixed cost > RPA cost. When RPA's cost is lower, its implementation is profitable. It should be noted, however, that the fixed costs from employees are more stair-like costs as not all employees become unnecessary at once but based on the number of invoices etc. that need to be handled manually. To gain units for this calculation, robots cost structure as well as costs and profits arising from it are discussed and listed. RPA has mainly fixed costs as one can read in subchapters "Situation after RPA implementation" and "Profitability". Therefore, it turns profitable as the number of units (e.g. invoices, pay checks, opening customer accounts) to process rises given that these units had variable cost, such as time it takes from employee to handle them.

1.4. Structure of this thesis

This thesis consists of introduction, theoretical background, an empirical study with analysis of findings from both theory section and empirical section and, finally, discussion and conclusions summarising the findings.

The theoretical part is divided into three chapters: financial administration, financial administration's automation without RPA and its automation with RPA. The theoretical chapters move from a wider topic to a narrower one. First entire financial administration is covered, then automation of financial administration and then automation with one specific solution, RPA. Indeed, these topics could be considered to form a tapering funnel ending with case study which handles more specific topic than any theoretical chapter. Chapters 2-4 are based on previous research.

Financial administration is the field where RPA and other automation solutions are applied to. It includes the processes this thesis aims to improve. In this chapter, financial administration and the processes commonly included in it are defined based on earlier studies and relevant literature. These processes are also divided into subprocesses when possible. Emphasis is put into the costs of financial administration especially in public organisations. The most common IT systems used in financial administration are also presented. Knowing them helps to understand what kind of software programs RPA interacts with.

The second theoretical chapter focuses on different automation solutions applicable in financial administration. The automation solutions' performances are discussed mainly in the field of financial administration but also to some extent in office environment in general to make comparison between these solutions capabilities in financial administration and general office environment. The requirements and platforms, e.g. scripts, for automation are also discussed.

The third theoretical chapter focuses on RPA, especially in financial administration, and is divided into subchapters too. The first subchapter focuses on RPA in general, how it works and how profitable it has been. The next subchapter presents RPA examples and the next its challenges. Final subchapter, "Alternatives of RPA", works also as a summary for alternative automation solutions and how they compare to RPA.

Empirical section of this thesis is a case study which examines utilisation of RPA in accounts payable process in a public organisation. The chapter covers situations before RPA, what tasks RPA conducts now and possibly in the future and how RPA works. Moreover, the current and previous states of financial administration in case company are explained. This chapter's sources have been interviews of city's personnel, public information provided by the city and some organisation and finance-related matters retrieved from city's Business Intelligence software. The interviews explain in detail where the robots have been utilised and what kind of challenges have been faced and resolved. "Results and analysis of the case" section analysis the findings from the case study and compares them to the findings from the literature. The findings are gathered together and used to sum up success factors found from the literature. Special emphasis is put into assessing case's profitability and gathering different costs and benefits. Common models for calculating profits are discussed as well. Another subchapter makes more direct comparisons to literature and is crucial into answering the research question. Matters compared are e.g. organisation and tasks where RPA has been used. Another subchapter presents ideas on further possibilities of RPA in case company. The last subchapter will discuss the reliability and validity of the case and the thesis.

In the "Discussion & Conclusions" chapter, the first subchapter "Conclusions" will summarise the findings of this thesis by answering the research questions. Then limitations, what own findings are worth, and critique are discussed. Suggestion for further research are also made including potential integration with cognitive solutions of AI emphasizing machine learning and expanding RPA research from case studies into a quantitative study that would map variables most likely leading to a successful RPA project.

2. Theoretical Background of Financial Administration

The purpose of this chapter is to define financial support activities, accounting and financial administration, how they relate and what tasks are included in them. The financial administration activities, especially accounting, is part of back-office operations which further include human resource management (HRM), information technology and customer care services (Basu & Nair 2012, 1679). Financial tasks are not necessarily support activities but primary instead as Collan (2016, 28-31) points out. In this thesis, financial administration is defined through processes included in it. Therefore, processes are listed. These processes subprocesses are called tasks. This chapter will also present some software required in financial administration. Emphasis has been put into literature that handles the same kind of financial processes and in software that Vantaa requires. This allows for better comparison in results and conclusion chapters. There are two duos whose research have been frequently utilised in this chapter: Sanna Lahti & Tero Salminen and Aleksandre Asatiani & Esko Penttinen. Both have also written about automation of financial administration. To explain financial administration and accounting, Atrill & McLaney have been commonly cited whereas Collan is frequently cited to explain system-related matters.

2.1. Financial administration and accounting

According to Atrill & McLaney (2006, 2), "*Accounting is concerned with collecting, analysing and communicating financial information*". In EU, accounting and its financial statements are made according to international financial reporting standards, IRFS (europa.eu). Generally, accounting could be considered numerical and economical information from a company. Finance is related to accounting as it, too, provides information to decision makers but finance is more about where the money for business is received and how they are invested (Atrill & McLaney 2006, 2). Accounting processes, such as billing and payment monitoring, do not require real-time response like customer call services but require rather batch-processing response (Basu & Nair 2012, 1679).

Accounting is usually divided to two sections: management (or internal) accounting and financial (or external) accounting. Atrill & McLaney (2006, 13-14) consider management accounting to be more specific, more detailed and more often reported. It is also less regulated than financial accounting and can provide information for the future as well. Management accounting may include other than monetary measures too, like number of units in inventory or personnel amount. Other example of internal accounting's specificity is that in addition to following numbers companywide, they are followed by business unit, cost centre, project, client among others (Lahti & Salminen 2014, 178). Accounts, too, can be more specific: e.g. instead of "Purchases with 24% VAT", several accounts are used like "office items", "other claiming costs", "cell phones" etc. (Vantaa BI 2018). For companies, religious organisations, municipalities and some sole proprietors financial accounting is obligatory by Finnish Accounting Law §1 and §1a and Municipal Law §120.

Financial administration (Fin. "taloushallinto") is not as well defined as accounting. Lahti & Salminen (2014, 16-21) consider financial administration a wider entity than accounting. They argue that financial administration is a system for organisation to follow its economic performance and report it both internally and externally. They divide financial administration to internal and external accounting, just like accounting is usually divided (e.g. Atrill & McLaney 2006, 13) and mention that financial administration can be considered a supporting process for the company. Therefore, the difference between financial administration and accounting seems to be rather blurry if not even non-existent with financial administration meaning the wider spectrum of accounting.

Granlund & Malmi (2004, 25) divide financial administration to following subprocesses: accounting and its methods, reporting, accounting software solutions, controlling and auditing. More precise approaches are offered by Lahti & Salminen (2008, 15-16) and Asatiani (2016, 43). Lahti & Salminen (2008, 15-16) name nine processes but in their second book the number of processes is increased to ten with addition of payroll accounting process (2014, 16-18). These are listed in table 2. Asatiani's (2016, 43) more detailed process distribution is added as appendix 1. In addition to processes named by Lahti & Salminen, they mention management of supplier, personnel and product register, filing complaints, financial statements and tax return as normal company tasks. Everaert, Sarens and Rommel (2008, 93-95) use a more straight-forward division: routine tasks including entry of invoices and interim reporting (e.g. monthly income and expense calculation), and non-routine tasks including accounting closures and financial statements. They find that the routine tasks are more likely to be standardized so another division could be standardized and non-standardized tasks. From Everaert et al. article (2008, 93), one could also consider other clerical processes to be for example answering phone calls and emails related to financial administration coming from different stakeholders. Another term, business administration, includes sales ledger, purchase ledger, bank connection, cost accounting, wages payment, inventory system, accounting system and working capital, making business administration a synonym to financial administration (Collan 2016, 28-29)

Table 2. Processes in financial administration and short description of phases/tasks involved in them per Lahti & Salminen (2014, 16-18).

Process	**Phases**
1. Purchase invoice process, i.e. accounts payable invoicing	Order, payment, entry (into accounting)
2. Sales invoice process, i.e. accounts receivable invoicing	Sale order, invoicing, payment, entry
3. Travel etc. invoice process (e.g. small purchases done by employees)	Order, payment, entry
4. Payments traffic and cash management process	Transaction and other execution handling
5. Fixed asset accounting process	Monitoring property, plant and equipment, depreciation, appreciation
6. Payroll accounting process	Salary calculation / work time measuring
7. General ledger accounting process	Deferral / reconciliation / yearly closing
8. Reporting process	Starts where other processes end
9. Archiving process	Data warehousing
10. Controlling	Setting up and following controls

Accounts payable process is now explained in more detail because the empirical material of this thesis is mainly received from purchase invoice team. For automation purposes, it would be optimal to receive all invoices as e-invoices because they are standardized and fully in electrical format. Purchase invoices with purchase order or with an existing repeating purchase contract have most automation potential as they may require no manual process but can advance straight to the payment phase if invoice matches order number or contract information respectively. Purchase invoice process has several subprocesses. They start even before financial administration has any role if acquisition department's order and accepting the deal is counted. The financial administration's tasks are booking, checking and approval, payment, reconciliation and archiving.

Typically, a ledger employee checks the invoice, books VAT and possibly other information and sends the invoice into approval circulation. Financial administration may also take responsibility for updating vendor information. (Lahti & Salminen 2014, 52-57, 66). Paper invoices, too, can be changed into electric format by scanning them but these documents are harder to utilise for invoicing software. It is common that companies outsource scanning to a specialised provider. This provider may possess an Optical Character Recognition program. This smart scanning program can automatically pick up data from paper invoice and turn it into text which is more readable for invoicing software. There is no guarantee, however, that scanner can pick up all relevant information. (Lahti & Salminen 2014, 64). Kaplan (2011, 118-119) mentions a case where Optical Character Recognition program was able to scan well over 90% of invoices and several accounts payable personnel have been moved to do other tasks and handle exceptions.

Centralisation is a common strategy to concentrate employees doing processes that require same kind of skills. Next subchapter will present an example of centralisation in form of financial shared services in some Finnish cities. In large organisations it is common that booking is done by the purchasers as they are expected to have the best knowledge regarding the invoice (Lahti & Salminen 2014, 67). Yet, Lahti & Salminen (2014, 67) recommend centralising the ledger employees as they are expected to have more knowledge on accounts and VAT legislation and centralised tasks are easier to automate. Lahti & Salminen, however, do not mention whether ledger employees have best knowledge of cost centres, activity codes ("toimintokoodi") and such.

Electronic archiving is the last process for documents such as purchase invoices and travel invoices. Its benefits include browsing, searching and combining data electrically and swiftly anytime anywhere. They are also easier to utilise for different kinds of reporting. Every archived document needs an individual number. (Lahti & Salminen 2014, 200-202).

Financial information has an important role in managerial controlling and planning. As planning includes budgets, long-term decision-making etc., it derives much from the usage of management accounting. Controlling means monitoring that the plans come to effect. Control requires dynamic flow of relevant information to make comparison between plan and real performance. (Atrill & McLaney 2006, 12). Lahti & Salminen (2014, 188-191) emphasise the role of internal controls too. The controls help to follow processes' efficiency, financial reliability and obeying laws and regulations. Failing to follow controls may have substantial costs. Approvals and user right requirements as well as expense limits, mandatory information slots, extraordinary input notifications, duplicate notifications and checking manual inputs' correctness are examples of controls. Business ID checking is also important to include into controls because the buyer is responsible for finding out whether the seller belongs to tax and VAT registries (Lahti & Salminen 2014, 60).

Lahti & Salminen (2014, 171-175,178-182) argue that reporting should present correct numbers and that there is only one result for one matter, i.e. taking information from different internal sources does not change the result. This requires that internal and external accounting are synchronised. Reporting itself can be divided into external and internal ones. The former includes official, even mandatory, reports such as VAT report and financial statements which can, voluntarily, be updated much more often than the law requires. Lahti & Salminen divide the latter into:

1. Financial reporting that includes e.g. budgets, forecasts, monthly financial monitoring and cost calculations. These reports may be created at regular intervals or ad hoc: based on the contemporary needs of the management. The reporter should comment anomalies in the report when possible.
2. Corporate performance management, aka financial performance management, reporting which can be used to create the same types of reports as financial reporting creates.
3. Business intelligence & analytics that covers especially different ad hoc reports. These reports use information from accounting/financial administration, ERP, big data and other operative software. A new challenge to reporting is utilisation of Big Data. Lahti & Salminen (2014, 171) cite that many companies see reporting and forecasting as the main financial administration tasks to be developed. Sometimes reports need to be distributed to several locations and persons; commonly via web portals and e-mail (Lahti & Salminen 2014, 185). This practice can be time consuming.

2.2. Costs of financial administration in Finnish municipalities

Financial administration's proportion of organisation's costs can vary greatly. In this subchapter, financial administration's costs are mainly handled from public sectors viewpoint as case organisation belongs to this group. Costs are compared between different cities in Finland as one can presume these cities are rather similar when it comes to their organisation, duties and requirements in the field of financial administration. Of these costs, invoicing-related business units form a substantial share (Espoo 2018, 74; Vantaa BI 2018). Some estimate of accounting costs in Finland may be derived by calculating the size of accounting agencies. In Finland accounting agencies employed some 12 000 people and the total revenue of the business was 970M€ in 2016 and ca. 1 000M€ in 2017 (Taloushallintoliitto 2017; 2018). The revenue has increased steadily from 2014 when it was 915M€. The productivity per employee has also increased as the number of labourers has decreased slightly in the meantime (Taloushallintoliitto 2017). These figures include only domestic outsourced financial administration: some organisations do these tasks themselves and others have outsourced them abroad.

The three largest cities in Uusimaa all do at least part of their financial administration internally. The revenue of Helsinki's financial shared services was 28,4M€ 2017 and Espoo's 5,9M€ (Helsinki 2017, 123-124; Espoo 2018, 74). Financial shared services proportion of cities' budgets is presented in table 3. In table 3 only expenses are included. Cities have also gained profits from their financial shared services, but they are not included in the table as it is hard to compare what kind of profits they are: internal profits or tax income doesn't tell a lot about the actual profit margin of these divisions (Helsinki 2017, 123-124). One just needs to remember that the actual cost of financial administration is at maximum these expenses but possibly somewhat lower. Based on the table, financial shared services' share of respective cities' budgets has varied very little from year to year. Since different cities may have concentrated different tasks into financial shared services, and changed tasks included in it over the years, the numbers are not necessarily comparable between cities. Moreover, not all financial administration is focused on financial shared services (Espoo 2018, 196; Vantaa 2017, 81,101). In 2018, all these cities have implemented RPA (Helsinki 2017, 123; Mussalo).

Table 3. Financial shared services' expenses their share of whole city's actual expenses 2016-2017 and estimate 2018-2019 (Helsinki 2017, 124,239; Espoo 2018, 74; Vantaa 2017, 181; Vantaa BI 2018; 2018a).

Millions	2016 €	2016 %	2017 €	2017 %	2018 €	2018 %	2019 €	2019 %
Helsinki	27,56M	0,65%	28,39M	0,67%	27,92M	0,64%	27,62M	0,63%
Espoo	5,05M	0,23%	5,95M	0,29%	5,75M	0,27%	N/A	N/A
Vantaa	3,55M	0,25%	3,56M	0,24%	3,69M	0,24%	~3,8M	0,24%

Espoo has made some estimates on the cost of a single financial administration task. They calculate that one sales invoice costs 2,12€ to process in financial services department whereas one purchase invoice costs 6,26€ in 2018. The volumes for the two are respectively 545 000 and 249 000. One can see that sales invoices form some fifth of financial service's expenses. The cost of purchase invoices is above quarter, and this does not include electric purchase orders and purchase services which are included into other financial services. "Other" group includes also accounting, financial statements and miscellaneous tasks. (Espoo 2018, 74). In Vantaa, accounts payable team forms a little above a quarter of financial shared services' expenses similarly to Espoo, but Vantaa's team is also responsible for several customer service tasks among others – a matter Espoo did not specify (Avain 2018). Accounts receivable team, too, requires a quarter of expenses whereas invoice team's share is a third and accounting forms the rest (Vantaa BI 2018). Lahti & Salminen (2014, 52) argued that purchase invoices are financial administration's most expensive process.

It can be hard to estimate the costs of one worker in either public or private sector. Generally, managers and professionals cost more than labourers whose tasks are more routine-based. In municipal sector, ledger accountant earned on average 2393€ plus side costs of ca. 25 % according to Vantaa (Vantaa BI 2018) whereas accountant earned 2562€ plus the same side costs in 2016 (KVTES 2017). Per hour that would be 2393 x 1,251 / 152 = 20€ and 21€ respectively rounded to nearest euro (Kuntatyönantajat 2017). Generally, the minimum wage in financial administration is likely the lowest pay grade in ERTO union's collective labour agreement. This was 1728€ + side costs of ca. 434€ (=25,1%) in 2017. Per hour that would be 2162€ / 159 = 14€ rounded to nearest euro. (Erto 2017; Pro-liitto 2016, 14-16). Because at least part of financial administration is possible to outsource abroad, salaries abroad should be compared too. In Finnish newspapers Poland and India have been mentioned as example countries where work has been outsourced. Per Warsaw Local newspaper (2017) the average monthly income of administration worker in Poland was 3231 PLN 2017. This is ca. 776€; roughly third of ERTO's minimum wage. GDP per capita was 24 times smaller in India and three times smaller in Poland than in Finland. If this ratio is the same with financial administration's salaries, these countries are substantially more affordable than Finland (World Bank 2018). Outsourcing may have other costs than just workers: the offshore company will take its margin and there may be monitoring costs, translation costs, additional training costs and delivery costs should any materiel be sent abroad. Indeed, one can notice in table

5 that offshore FTE is estimated to cost one third of onshore worker. However, there is no specification which country these figures refer to. Outsourcing in general is examined in further detail in chapter “Alternatives of RPA”.

2.3. Software used in financial processes per literature

This chapter presents financial administration software that have been mentioned by Lahti & Salminen, Collan or Chaudhuri, Dayal & Narasayya. These are Enterprise Resource Planning (ERP), invoice circulation/ledger, Business Intelligence and spread sheet software. In the next chapter automating and making these software systems communicate with each other is explained in more detail. E.g. e-invoicing is considered part of the latter chapter. This chapter is also relevant to understand in what kind of software environment RPA works.

ERP program is an integrated software system aiming to distribute information between several business processes within an organisation and even outside of it. Introduction of an ERP software can be challenging as it frequently requires changes to current business processes. (Aloini, Dulmin, Mininno 2012, 484). Collan (2016, 30-32) argues that ERP modules can include all previously mentioned business administration tasks. The requirements for ERP are different for a small company and a large one (Lahti & Salminen 2014, 39; Collan 2016, 32). According to Lahti & Salminen (2014, 39), smaller companies may require only a general and a purchase ledger and an invoicing system - or even less if financial administration is completely outsourced. Medium sized enterprises are more likely to need the ERP to include cash management, e-invoices and travel invoices among others. Large companies may require, in addition, treasury, internal invoicing, data warehouse and order processing among others. Table 4 is a shortened version of Lahti & Salminen’s figure four and exhibits processes that a large public organisation could well execute with ERP. Some examples of ERP providers are SAP, Oracle and Dynamics AS. When it comes to financial administration, a more specific requirement for ERP is drill down hierarchy of the data: e.g. organisation can be examined by department, sub-department and cost centre and/or accounts are grouped into larger sections and the highest groups in the hierarchy are income and expenditure groups (Lahti & Salminen 2014, 178). Unlike Lahti & Salminen, Collan (2016, 35-37) doesn’t mention ERP to be a reporting software but considers that management accounting, reporting, budgeting and cost calculation among others are better done with Management Information System.

Table 4. Large company's ERP requirements by Lahti & Salminen (2014, 39) shortened for public organisation.

Purchase and travel invoices	**Accounting and reporting**	**Sales process**	**Payroll and finance**
Purchase ledger	General ledger	Sales ledger	Bank connection
Electronic purchase invoice handling	Automatic deferrals	Accounts receivable management	Cash management
Travel and personnel expense invoice handling	Forecast and budgeting	E-invoices	Concern account system
Order handling	Management, concern, KPI, BSC and business unit reporting and report portals	Internal invoices	Treasury
Acquisition portals	Data warehouse	Other billing applications	
	Business Intelligence		

ERP does not always handle e-invoices a company has received (Lahti & Salminen 2014, 53). Some software are designed for invoice and document circulation plus their approval and archiving, i.e. ledger activities. Such software is for example Rondo offered by CGI. It has functions for sales and purchase invoices and acquisitions. Rondo can also be connected to e.g. ERP, e-invoice transmission and invoice scanning. (CGI 2018). Ledger software can be integrated into accounting software in addition to ERP (Lahti & Salminen 2014, 58).

Excel is a common tool used by many companies. It is often taught at schools and required in work places. Excel has its flaws, however, as its information is most of the time static and not dynamic which is needed in many cases such as following sales of individual sales persons. It can also be hard to use Excel when several people, possibly in different sections and locations, update the same file. This is eased by using Office365 cloud-based package, though. Excel can have more functions than being used as a calculation and visualisation software; its format makes it easy to utilise for robot too as the interview points out in "Situation after RPA implementation" chapter.

Management information system mentioned by Collan (2016, 36-38) included internal accounting features whereas ERP included external accounting. These internal accounting features are cost accounting, business controlling and planning among others. Such processes require exact information on company and Collan refers to such information as Business Intelligence. Chaudhuri et al. (2011, 88) define Business Intelligence software as "*a collection of decision support technologies for the enterprise aimed at enabling knowledge workers such as executives, managers, and analysts to make better and faster decisions*". BI technology utilises the large amounts of data organisations receive from different sources, such as e-business transactions. (Chaudhuri et al. (2011, 88). Business Intelligence software are not always directly part of the ERP, i.e. provided by the same manufacturer. Business Intelligence software are e.g. SAP BI, IBM Congos, SAS, PowerBI and Qlikview which are commonly emphasizing the data visualisation and dashboard capabilities of their respective products (Abzaltynova & Williams 2013, 41; Qlik 2018; PowerBI 2018). Abzaltynova & Williams (2013, 41) define BI software's main requirement to be fast provider of information for the decision-makers. They further argue that BI software lack planning features but include data collection, analysis and dissemination capabilities. Abzaltynova & Williams (2013, 42-45) consider the analysis capabilities of tested BI softwares to be slightly less than good on average, though.

Cloud services work as digitalisation provider and reduce need for physical memory space. If data is stationed online, i.e. in cloud, it can be accessed by different employees, and robot for that matter, in different locations unlike in a case where data is only in computer's hard drive. Shared hard drive may work in a single office but less likely in a company with a lot of locations. Cloud can also eliminate the cases where worker in one locations needs to ask that certain data is send to her/him via e-mail, fax, disc etc. saving the potential sender's time. Lacity et al. (2015a, 12) mention, though, that cloud-computing has been difficult to handle for IT.

3. Financial Administration's Automation Solutions in Current Literature

This chapter will cover different automation solutions for financial administration. The introduction will explain digitalisation and what kind of environment digitalisation demands. The first subchapter focuses on what Davenport & Kirby (2016, 21-23) call repetitive task automation solutions. These are human-configured solutions where technology is not capable of context awareness and learning, i.e. level three intelligence in table 1. These less-cognitive solutions are divided into user interface-changing and software architecture-changing solutions (Slaby & Fersht 2012, 5; Lacity et al. 2016, 24-28). From the latter, e-invoicing is thoroughly covered because it is created especially for financial administration. The second subchapter focuses on the cognitive solutions capable of learning per Davenport & Kirby (2016, 23) or otherwise defined cognitive by Zarkadakis et al. (2016). There are few other writers whose texts have been frequently cited to create the framework of this chapter. They are Sanna Lahti & Tero Salminen and Aleksandre Asatiani & Esko Penttinen all four writing about financial administration in general, too.

Even though this chapter will mainly focus on automation solutions, some other ways to improve performance of financial administration exist too and could work as a comparison to automation solutions. Literature has discussed two manual labour solutions that can reduce costs of financial administration: shared services briefly mentioned by Lacity et al. (2016, 29) and outsourcing. Outsourcing has been an alternative to inter-company manual labour. Lacity et al. (2011, 221) estimated business process outsourcing market to be 279B$ 2011. Moreover, Lacity et al. (2015a, 3) list following levers to improve back-office as a whole: "*Centralize physical facilities and budgets, standardize processes across business units, optimize processes to reduce errors and waste, relocate from high-cost to low-cost destinations, and technology enable with, for example, self-service portals. Further developments in automation, including software robots, have added a sixth lever*". Of these, centralization and outsourcing strike as manual solutions whereas process standardization, process optimization and self-service portals sound more both and.

According to Lahti & Salminen (2014, 11-13), digital financial administration ("digitaalinen taloushallinto") is more than e-invoices and electric handling of invoices, i.e. more than paperless office. Furthermore, Lahti & Salminen (2014, 15) would exclude electric financial administration ("sähköinen taloushallinto") from digital financial administration. They argue that digital financial administration includes all levels of economic processes a company and its related organisations have. In addition to e-invoices, use of cloud-based services is an example of digitalisation. Based on Lahti & Salminen's ideas, one could argue that digital financial administration is electronic financial administration processes done in an environment where different processes and software are connected, i.e. can "talk with each other" to achieve process automation. This "talking" could be for example the possibility that two software can read data from the same database.

To better understand Lahti & Salminen's ideas on interface and inter-software communication, application programming interface, API, should be explained. Per Rama & Kak (2015, 76), API is "*a focused expression of the overall functionality of a software module in terms of method declarations that can be called by others wishing to utilise the services offered by the module*". API provides tools to create a program which in turn may allow communication between different software. However, there can be limits to using API with many commercial software and additional modification is required. Some software programs have API features already implemented in them when bought: e.g. Excel (Office 2018). Furthermore, creation of an API can be challenging as it is hard to change afterwards and can cause problems to the codes deriving from the API. (Rama & Kak 2015, 75-79). As will be explained later, another type of interface is user interface, UI, that robotic process automation uses (Hodson 2015; Asatiani & Penttinen 2016, 68).

Lacity & Willcocks (2015) have noted that different systems quite generally cannot complete all subprocesses of a larger automation process from beginning to end. Indeed, software from different manufacturers do not necessarily communicate with each other. Typically, an employee must extract data from one system and add it to another one. For example, creating an ad hoc report may require two software: a spreadsheet where the data is imported and possibly modified and an ERP where the information is gathered. Some software, like SAP BI and Qlikview, have an "import button". Nevertheless, this is not quite practical if a large amount of these items needs to be imported daily. Then "buttons" or commands creating certain data-output may not be the fastest method but automation of these subprocesses.

An important part of digitalisation, "talking", is interorganisational electronic data interchange aka EDI. This allows different companies to exchange information swiftly. For example, company A sends a delivery order and company B answers it by clicking "verify" so that company A knows that their order is being received. (Lahti & Salminen 2014, 60). Common EDI formats are

EDIFACT and XML. Another cross-company digital information transfer option is e-invoice. Another type of structured data that utilises XML is XBRL financial reporting. Whereas EDI is usually only made to work between few companies, e-invoice requires no modifications and works between several companies. (Lahti & Salminen 2014, 28,65,176).

As City of Vantaa's invoicing programs focus on using XML script per interview and it was also referred to by Lahti & Salminen (2014, 23), this format is better explained in this paragraph. In addition, Hernandez-Ortega (2012, 16) argued that e-invoices are commonly sent in XML format. XML stands for "Extensible Markup Language" (w3 2016). It is a flexible text format based on SGML, "Standard Generalized Markup Language". LUT has a previous master's thesis focused on XML's performance: Henri Laamanen's "XML-databases' performance comparison". He cites Vuokko Vanha-Vuori's 2005 article "Proseduraalinen ja rakenteinen dokumentti" that structured data, which XML presents, has in addition to main information also description of structure. As an example is mentioned surrounding postal code with word address in chevrons, i.e. <address> 00100 </address>. Even more extensive use is possible as under "address" there can be subgroups of "postal code" and "street number" etc. (Laamanen 2005, 9-12).

3.1. Repetitive task automation solutions for financial administration

Automation solutions for digital environment have been divided into two groups, lightweight IT and heavyweight IT, based on the layer of the system interacted with. Robotic process automation, as well as scripting and macros, belong to the lightweight group as they interact in user interface. (Lacity et al. 2016, 24; Penttinen et al. 2018, 4). Lightweight IT-based configuration tends to be suitable for business professionals in addition to IT ones (Lacity et al. 2016, 24). Many Windows Office tools have macros which can create internal commands via recording or coding. There are other coding software too like MATLAB and r and several code languages used by different software: Python, SQL, C++ among others that can be used for automating certain solutions in office environment. (Moffitt et al. 2018, 4). Once coded, the commands can be used, hopefully, in a fraction of the time required by manually doing the same process. An example of using VBA macro to automate a process is making a loop that turns data copied from pdf to useful data in Excel. Lacity et al. (2015a, 27) mention yet another technology working in UI, one that is colloquially called "screen scraper". The screen scraper records human's actions and uses UI to e.g.

move information from one system to another but it relies on coordinates, i.e. exact locations on different screens and such. If anything is moved, the technology backfires.

Heavyweight IT are solutions where software interacts with deeper layers than user interface, namely business logic and data access layers, and requires programming done by IT-professionals (Lacity et al. 2016, 24). To function, heavyweight IT solutions require stability of these layers (Penttinen et al. 2018, 2-3). Lacity et al. (2015a; 2015b; 2016) and Slaby & Fersht (2012; 4-5) have mentioned business process management and service-oriented architecture (SOA) as heavyweight automation solutions. Buying a BPM solution with automation capability is not the only “heavy weight” solution, but other less heavy ones are also available: current system can be extended or a middleware solution, e.g. library with API, can be acquired instead (Penttinen et al. 2018, 5). Configuration of heavy-weight IT is done by programming which is commonly IT staff’s skill whereas lightweight IT has been configured by business personnel too due to it not needing programming skills (Slaby & Fersht 2012, 5; Lacity et al. 2016, 27-28). Therefore, e-invoicing could be considered part of the heavyweight IT as its configuration and attachment to existing programs, like ERP, likely requires both coding and IT staff’s knowledge.

An example of process automation is that the customer sends e-invoice that is automatically read and send to ledger/accounting of company’s invoicing software. Electric invoices require less time to handle as no human worker is required to transfer the invoice into an invoicing system that can be part of the ERP software or share the same API (Maventa 2018, Barlow & Barge 2001). Indeed, as companies and public organisations often receive and send a vast number of invoices, automation in this field has a high potential. This demand is at least partially answered with electronic invoicing.

Electronic invoicing means transferring bills electronically, commonly via Internet, between parties. E-invoice can utilise at least PDF, XML, EDIFACT, html, doc, xls, jpeg and txt formats. (Hernandez-Ortega 2012, 16). Per e-invoice provider, e-invoice requires no scanning or manual input into financial administration software and enables automatic payments and input into accounting (Maventa 2018). E-invoice should follow certain standard in order to allow different software to read the bill. Like in case of previously mentioned EDI, invoice data is automatically sent to the buyer when order is made. The information can then be entered into the ledger using the standardized form present in the invoice, such as XML. (Barlow & Barge 2001).

E-invoices can be used as a catalyst for further automation: Lahti & Salminen (2014, 67) argue that vendors who send repeatedly invoices which are always booked the same way, could be set to automatic booking, “oletustiliöinti”. After most automated purchase orders, Lahti & Salminen (2014, 58-59,68-69) define contract invoices second most suitable invoices for automation. Such contracts are e.g. rents, leasing, fixed service fees and even electricity bills. This kind of automation needs a contract database to be founded. Contract information should include vendor name, contract number, payment date, duration of contract and possibly sum in addition to booking information. Furthermore, the approver in error cases can be predetermined and the invoice automatically transferred to that person for manual handling. Purchase order information is already defined by the buyer, so the organisation has better possibility to include required information in the leaving invoice.

E-invoicing can be successful in decreasing costs, environmental impact, postal delays and errors (Hernandez-Ortega 2012, 16; Penttinen 2008, 4). Especially compared to paper invoices: a paper purchase invoice can, according to Penttinen (2008, 4), cost over 30 euros to a company whereas fully automated e-invoice process costs approximately one euro. Lahti & Salminen (2014, 59) estimate the cost reduction to be up to 90%. Both mention that there are options between full automation and fully manual work. Penttinen (2008, 15) further details the processes of fully manual invoice process as opening mail, typing invoice into accounts payable system, input to online banking system, approval, archiving, sending to accounting, booking in accounting. Automated process is depicted in figure 3. Penttinen (2008, 16) mentions that sending an invoice does not provide as large savings but suggests them to be up to slightly above 40% too. Automated process consists only of manual input to Financial Management System and automated sending of the invoice plus automated arrival to receiver’s system. One should bear in mind that these both examples are from micro company’s point of view and that the price of a working hour is estimated to be 100 euros (Penttinen 2008, 16). In many companies and other organisations, the price of a working hour is arguably under 100 euros even when counting the estimated opportunity costs. Some cost estimation is presented in chapter “Cost of financial administration in municipalities”.

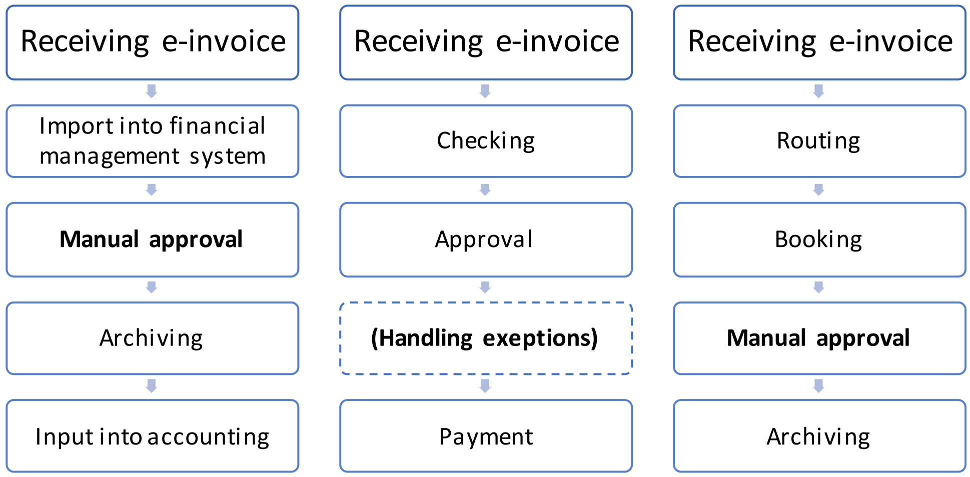


Figure 3. Electric invoice process per Penttinen (2008, 15), Lahti & Salminen (2014, 57) and Vantaa city in automated situation (interview). Manual tasks are bolded. In case of Vantaa and Lahti & Salminen, this applies only for matching purchase order or repeating contract, in other cases there is need for two checks and approvals in Vantaa city (see chapter "Situation before RPA implementation"). Even if not mentioned in respective references, archiving and at least paying is likely part of all purchase invoice processes.

A combination of e-invoice and ledger software who together automate the entire invoice process (including even payment) can have substantial cost savings. Both Penttinen (2008, 4) and Lahti & Salminen (2014, 59) estimate that with this method the cost of a single invoice can be reduced by 90-97%. RPA needs to give savings beyond this to be even more profitable. Alternatively, RPA may not have to compete with this option but to supplement it: invoices that cannot be fully automated with e-invoice plus suitable ledger software are then directed for a robot to complete.

3.2. Intelligent automation solutions for financial administration

Davenport & Kirby (2016, 23) argued that context awareness and learning capabilities to be highest level of intelligence machines have reached. Types of this intelligence were according to them machine learning, neural networks and IBM Watson among others. Lacity & Willcocks (2015) mention Watson supercomputer too. The Watson supercomputer with its cognitive capabilities is not considered an alternative for any specific automation solution but more like an addition to the wider field of process automation. Zarkadakis et al. (2016) offer another definition for cognitive automation: it mimics human cognition and focuses on complex, exploratory and creative tasks. The cognitive automation relies heavily on machine learning and can therefore become capable of pattern recognition, big data understanding and related tasks. These tasks can be voice related like voice recognition, transliteration and translation of speech and picture recognition (see appendix 2). Zarkadakis et al. (2016) further mention that social robots may include same features as cognitive automation but also same as RPA. Social robots may be physical units that are then taught to execute suitable tasks. An example of social robots is package finding robots that bring the deliverable packets to human workers waiting at platforms. The robots have decreased the time it takes to fulfil orders and, due to their small size, have enabled giving more warehouse space to products and less on aisles.

Chui, Manyika & Miremadi (2015) from McKinsey mention AI and machine learning as one of the most important automation tools. They argue that as much as 60% of current employments, both modestly and well-educated, could be at least partially automated with current technology, file clerks being one of the most automatable employees. They further argue that routine and highly repetitive tasks are most likely to be automated. These tasks automation will be handled in more detail in the next chapter.

Machine learning in automation was mentioned by Davenport & Kirby (2016) as well as Zarkadakis et al. (2016). Ertel (2011, 161) views ML as an alternative in cases where the programming becomes extremely complex. In his lecture material, Mezei (2016, 20) suggests that machine learning is useful when: "*Human expertise does not exist, humans are unable to explain their expertise, solution changes rapidly in time or solution needs to be personalized to particular cases*" Of these cases, the last one seems suitable for RPA as the information RPA is supposed to modify or meditate may have several different formats, e.g. documents in pdf or xls format or XML script, and styles, e.g. documents from different vendors use different standards (KPMG 2017, Lacity et al. 2015a, 5-6; Penttinen et al. 2018, 6-10; interview). Ertel's (2011, 164) example of ML is that after training machine can, based on several features, create classes. This can be useful in financial administration if there are a lot of input features that need to be set into certain labels, such as cost centres. However, in many cases simple if rules can be used like "if input is x1, x2 or x3 then output (e.g. cost centre or account) is y1" etc. with final class being "if else then y10" where y10 is named other costs or something similar. This if else can include all inputs that are not, say, cases x1-x20. Should the if condition have a dire need to include extremely high amount of classes/inputs to classify, then machine learning strikes practical.

4. Robotic Process Automation in Automating Financial Administration

This thesis scrutinises robotic process automation's capability in this financial administration. The first subchapter will explain what robotics process automation is, how it functions and how profitable it has been. The second subchapter will then explain where RPA is used and next one what challenges it has faced. The last subchapter will compare RPA to other solutions to improve financial administration. Most commonly cited researchers are Mary Lacity, Leslie Willcocks & Andrew Craig who have written several articles about RPA and automation. Asatiani & Penttinen, who had also scrutinised other financial administration's automation solutions, are also frequently cited. Because both RPA and automation of financial administration are rather detailed studying fields, there are rather limited number of sources and therefore limited opportunities to compare different writers' ideas about the subjects. Moreover, it must be noted that these writers have written several articles about RPA during many years and could well be considered experienced researchers in respective field. There are many other writers who have scrutinised RPA, too. Namely Slaby & Fersht, Zarkadakis, Jesuthasan & Malcolm, Moffitt, Rozario &Vasarhelyi, Davenport & Kirby, Boulton, Del Rowe and Hodson. It is common that these writers have used each other's papers as references. All these articles are written in this decade as one can notice from the reference list.

4.1. Introduction to RPA

Robot process automation automates digital processes, as the name already indicates. Per Davenport & Kirby (2016, 22-23), robotic process automation is an automation method for repetitive digital tasks, and it is, also per Moffitt et al. (2018, 1), a type of cognitive technologies. Other types of cognitive technologies are image recognition, industrial (physical) robots and machines analysing numbers in structured format. RPA is considered by Del Rowe (2017) as part of the field of artificial intelligence. Software robots refer to software instances, i.e. applications, not any physical units. (Penttinen et al. 2018, 4; Moffitt et al. 2018, 1).

The clerical work that is possible to automate with RPA needs to be repetitive and rule-based. Functions that can be repeated are, for example: searching from database, moving data or simple text from one location to another, like email or document to ERP, and creating new targets such as opening new customer accounts. (Hodson 2015; Boulton 2017). Lacity & Willcocks (2015) mention as examples transferring data from email or spreadsheet software to ERP or CRM and vice versa. Zarkadakis, Jesuthasan and Malcolm (2016) summarise that RPA is most effective with “high volume, low complexity” tasks. Asatiani & Penttinen (2016, 68) mention that RPA is useful when software don’t have their application programming interfaces linked and intra-software communication is possibly only by front-end user, namely human worker or RPA. Indeed, Slaby & Fersht (2012, 6) further argue that RPA is well suited for situations where a process requires use of several systems. Some time is of course needed for robot to be implemented, i.e. learn what to do. Slaby & Fersht (2012, 5-8) estimate the time required for company staff to master and implement RPA in business processes takes few months which is, according to their research, shorter than the time required to master software architecture and relevant programming languages. They estimate the time to implement the RPA to a company takes some four months and the implementation of later processes takes two months or less. Asatiani & Penttinen (2016, 68) estimate the implementation to last a fortnight or a month whereas they estimate software integration to take up to years. Lacity & Willcocks (2015) argue that company personnel may learn to use RPA in a few weeks. Both Boulton (2017) and Lacity et al. (2015a) emphasise that a company planning to acquire RPA needs to deeply analyse what kind of processes are present in the tasks that will be modified with RPA. In the future, RPA is expected to work more alongside artificial intelligence and machine learning. They would allow RPA to execute new functions based on unstructured inputs, i.e. rules created by itself without direct human interaction. (Boulton 2017).

After following how human worker executes different tasks, robot mimics human’s way of using computer by repeating the same processes/functions it had observed. No changes to software are required. (Digital Workforce 2018a; Moffitt et al. 2018, 2). Asatiani & Penttinen (2016, 68) further argue that RPA is used with logical statements, process chart with icons or screen captures from the processes that the robot needs to execute. To sum up, a robot is configured by recording a process or creating a process chart for it to use. The robot does not require a screen to complete its tasks; if one is provided, human can observe how RPA works: it copies, pastes and types like any human worker. (Hodson 2015). This is because robot is directly linked to the software and uses same keyboard and mouse controls as a human worker. Per Lacity et al. (2015a, 27) RPA finds data from HTML, Java Access Bridge and Citrix surface solution scripts. Since HTML and XML are related, the latter works too. RPA can work tirelessly, even during nights and holidays, and with no human errors by doing so (Del Rowe 2017). Indeed, Lacity et al. (2015a, 4-5) also point out that the robot can work 24 hours every day. They also elaborate that robots have no physical units and a company may need several robots as one software licence gives only one robot account. One should also consider whether they can make the input material more appropriate for the robot: e.g. have documents include all relevant information for robot to read them precisely (Asatiani & Penttinen 2016, 70).

No application programming interface changes and not necessarily any kind of coding are used (loops can be used inside RPA window as KPMG points out) nor any saving of functions and formulas as in many other forms of automatization. RPA has also no need to change system's programming. (Del Rowe 2017; Hodson 2015; Lacity & Willcocks 2015; Asatiani & Penttinen 2016, 68; KPMG 2017). RPA utilises Microsoft Vision-like tool where the human user organises icons, "steps", to create a chain of commands (Lacity & Willcocks 2015). Based on tutorial video in Youtube by KPMG consulting group, icon types can be start, process, action, choice (yes or no etc.), loops and alert among others. As even code can be one icon, the difference between coding and RPA can become blurry. This is elaborated by Lacity et al. (2015a, 7) that coding is already within the icons moved and generates automatically, unlike with business process management tools. Lacity et al. (2016, 23) present in their paper figure two displaying a "process studio" where flowchart is created to give RPA commands. Figure 4 is a modified version of this figure, with additional information from KPGM's video, and present the idea on how purchase invoice process could be modelled in RPA. RPA works based on rules and should therefore be modified to understand more than one input case: i.e. understand some exceptions in the workflow (Lacity & Willcocks 2015, Zarkadakis et al. 2016). RPA may use Excel as a medium software to e.g. move invoice from email to ERP (KPMG 2017). Such two systems involving task is called "swivel chair process" (2015a, 5-6). Unlike, say, Excel VBA macros, RPA icons are not clicked to activate them. Once a certain subprocess, e.g. opening an email, is trained to a robot, it can be copied to all further flowcharts requiring this subprocess (Lacity et al. 2015b, 11; Penttinen et al. 2018, 4).

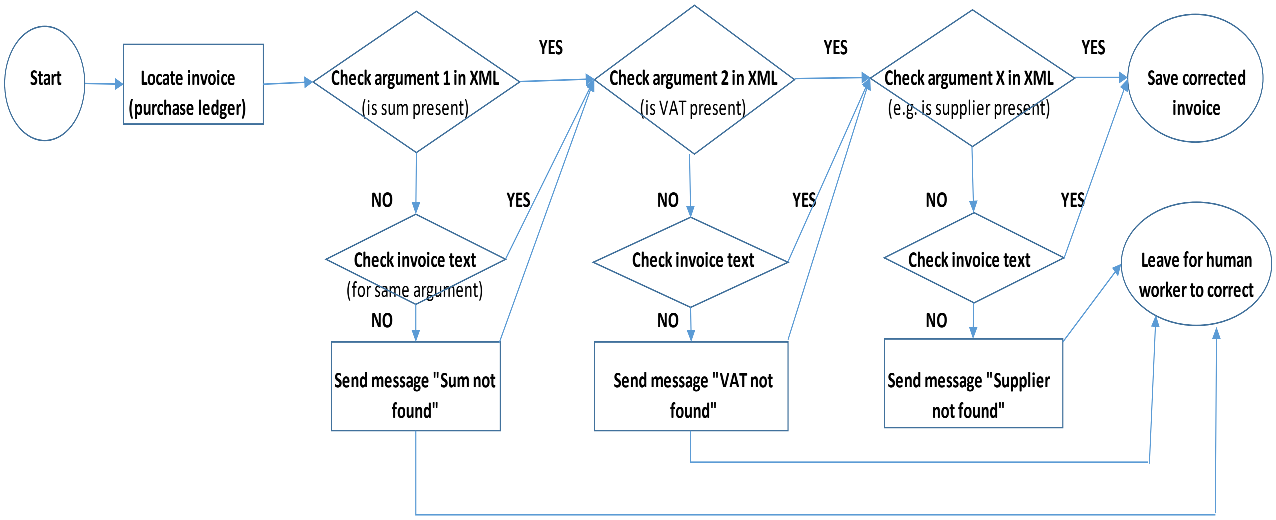


Figure 4. A crude presentation of the logic behind robotic process automation of purchase invoice approval. In this example RPA works only inside invoice circulation software. It could in the beginning e.g. collect invoice from e-mail attachment or in the end send information to. The messages in the message icons could be send to, say, Excel instead of just leaving them to circulation software. Furthermore, this example only checks information from the invoice, the robot can also write things in the software: e.g. fill in gaps in invoice information like account numbers for debit and credit. (Applied from: Lacity et al. 2016, 23; KPMG 2017; Penttinen et al. 2018, 8).

Lacity et al. (2015a, 30-31) recommend that an organisation has one employee working as the "head of robotic automation" managing the project, reporting its development to higher management, cooperating with IT and possessing a crucial role in software, and like, upgrading. Lacity et al. (2015a, 33) further recommend that in addition to the head of robotic automation there should be a group of other people also taking part in the RPA project. This group should include IT personnel and the employees whose tasks are being automated. They list the roles as:

1. Process analyst creating opportunities and process definitions.
2. Process developer designing, developing, testing and supporting RPA.
3. Test analyst testing automation from business process point of view.
4. Process controller administering, coordinating and controlling automated processes.
5. Service analyst supporting RPA production.
6. Programme manager overseeing the creation of RPA.
7. Automation manager directing RPA to support existing processes and create new if needed.

They mention too, that more experienced RPA-utilising organisations may have employees that are familiarised with several of these positions.

In addition to improving process flow, RPA may yield significant returns (Lacity et al. 2015b, 5). CGI (2016) estimates that a municipality with 100 000 invoices a year may save up to 135 000€ by implementing RPA. According to Lacity & Willcocks (2015a, 18), the same telecommunication firm mentioned by Hodson (2015) was able to process at least 400 000 transactions a month with 160 robots. The return on investment was reported to be above 650% in a few years. They also mention a saving of 30% per process in another case related to data collection with velocity of 120 000 transactions per month. Lacity & Willcocks (2015; 2015b, 9) mention other three-digit percent returns too but also that common cost savings had been 20-40% early this decade. Moreover, they estimate that a robot can do structured tasks of up to five humans. Helsinki (2017a) has found out that RPA can save at least 2,5 working days of one employee per month by reconciling purchase ledger. Boulton (2017) cites Dave Kunder from Deloitte Consulting LLP that RPA may do certain tasks in weeks whereas a human would have required even over a year. More precise personnel savings are listed by Asatiani & Penttinen (2016, 68) who cite that a robot may cost mere 10% of that of company's own worker and 33% of an off-shore worker (see table 5). It should be noted that the figures estimate the cost of RPA compared to human; Slaby & Fersht (2012, 1,11) have further argued that one robot can do a work of 1,7 humans on average but cost 50% less making it three times more profitable than offshore worker. Slaby & Fersht (2012, 9-10) mention a case of eligibility checking and letter sending where payback period for RPA investment was 6 months. In this case the robot was able to do the task three times faster with 10% of human worker's cost. In another example, they too refer to the "large telecom operator" which could be the O2 discussed in more detail in the next sub chapter. Cost savings can become from more than just speed: in one company, electronic ID searches had mistakes decreased thanks to RPA. Palkeet (2018a) has estimated that with RPA, and other automation solutions, they have improved efficiency by 20%.

Table 5. Amount of FTEs a robot can replace. Asterisk means that it is not specified whether article refers to foreign or domestic FTE.

Company/business	Domestic FTE	Foreign FTE	Source
	2-5*	2-5*	Lacity et al. (2015)
Helsinki/financial administration	ca. 0,1 (2,5 d per m)		Helsinki (2017a)
	5-10 (cost is 10-19% of FTE)	2-3 (cost is 33-50% of FTE)	Asatiani & Penttinen (2016). Also Slaby & Fersht (2012) for lower
		3 (costs 33% of FTE)	Lacity et al. (2015b)
	≤ 5*	≤ 5*	Lacity & Willcocks 2015

Garberg (2017, 51-52) surveyed the cost of RPA in his thesis and based on interview writes the price to be 40 000£ for 5 RPA robots per year plus 350 000 NOK from implementation. Altogether some 45 000 + 35 500€ respectively and 9000€ + implementation per robot with 31.12.2017 exchange rates. Slaby & Fersht (2012, 1) argue that RPA costs 15 000£, with 2012 rate 18 500€, or less a year. In another example Slaby & Fersht (2012, 10) cite that to one company 10 robots cost 100 000£ a year plus development of 80 000£.

Per Lacity et al. (2015a, 4), RPA software is provided by at least following companies: BluePrism, UiPath, Automation Anywhere, Celaton and IPsoft meaning that there is potential for tendering out. There are also companies that sell RPA services, in addition to the licences for these robots, like Digital Workforce mentioned earlier. Indeed, the client just needs to know what they want, and the service providers then adjusts the robot to fulfil these requirements. Boulton (2017) cites in his article that RPA spending will increase by 40% annually from 2015 to 2020. He also mentions that even though in 2017 only a tenth of large enterprises used RPA, the portion will increase to 40% by 2020.

4.2. Examples of RPA

Hodson (2015), Lacity & Wilcocks (2016) and possibly Slaby & Fersht (2012) refer to telecommunication provider Telefónica O2 as an example of successful RPA adoption. O2 had outsourced most of its back-office processes and almost 90% of its personnel before adopting RPA. Before RPA some processes were removed, e.g. legacy process to verify orders because error rate was 0,01%. The first tasks given to robots required utilisation of several software. RPA provider's own consultants were working onsite to implement these processes at first but after three months O2's own personnel, eventually three persons, did the process automation themselves. With 10 processes, the RPA was expected to pay back in 10 months whereas BPM done by IT would have required three years to break even. After five years 15 processes were automated making up 35% of back-office transactions including credit checks and order processing. Other finding made by O2 was that RPA needs thorough instructions to prevent certain kinds of "common sense" related errors. O2 reports that its 75 robots handle up to 500 000 transactions per month and without RPA 250 FTEs more would be required to handle respective transactions. The ROI is calculated to be at least 650%. (Lacity et al. 2016, 25-29).

Hodson (2015) presents several examples where RPA is utilised. In customer service sector, customer's phone number used to be manually moved from one database to another. Now a robot does this process. Actual service process is still done by a human. In data searching robot is used to search legal texts to answer questions related to law. The robot's search is likely both faster and wider (i.e. searches from places not likely thought by any person) than that done by a human. One should bear in mind that the user still needs to figure out the right questions. In medical field robot can learn to find fitting medical persons' notes. In short, the robot does the same searches as any human and collects the most appropriate sources and provides an answer based on them. Lacity & Wilcocks (2015), too, have examples of RPA in action. In a company that handles insurance brokers' premiums, robots add supporting documents, detect anomaly as well as include market information to the documents. Per Boulton (2017), RPA can be used to fill policy management data into claims processing files. A large field for RPA is banking and insurance industry in e.g. data collection on transactions (Boulton 2017, Lacity et al. 2015a, 17). HRM can implement RPA to create new employee accounts like payroll ID, email, access rights and so on (Lacity et al. 2015a, 5). RPA's potential has been examined in logistic processes too as Garberg's (2017) thesis points out. Penttinen et al. (2018, 8) have observed use in capacity checking in certain location. In Lintukangas' (2017) thesis, RPA's potential in indirect procurement, i.e. acquisition of supplies not used in production of goods but in companies' interior/supportive operations (Kim & Shunk

2004, 153), was scrutinized. She suggests based on score table that RPA has highest potential in "approval circulation, invoicing, order tracking and receiving the order as well as supplier data management" (Lintukangas 2017, 53-54). In more detail, this meant monitoring vendor data and ensuring the data symmetricity, gathering data from invoice, as well as checking their correctness, and sending email to chosen recipients when they need to approve purchases. Furthermore, Garberg (2017, 43, 50-57) examined in his thesis how RPA suits for address change notification, material movement ticket and delivery note concluding that implementation should be profitable. Lacity et al. (2015a, 4) have observed that at least 35% of certain company's back-office processes were automated with RPA.

The previous paragraph examined cases where RPA has been used in office environment in general. There are several accounting and other financial administration specific processes too in which RPA has been implemented. As mentioned, the primary requirements for RPA to work are repetitiveness and that there are no exceptions present. Moving information from one software to another, e.g. sending invoice from email or such to ERP is usually the first example to come out (KPMG 2017; Hodson 2015). Hodson also lists opening new accounts and resetting forgotten passwords. Slaby & Fersht (2012, 5) have some general examples of RPA utilisation; of these at least account review, creation of credentials and general ledger account maintenance could be utilised in financial administration. Moffitt et al. (2018, 3), too, have listed accounts receivable and accounts payable as repetitive and routine processes and added payroll, reconciliation and internal control testing in auditing. Many processes listed by Lintukangas (2017, 68), such as vendor creation, invoice approval reminders, reconciliation of accounts and data checking for invoices are present in financial administration. Asatiani & Penttinen (2016, 70) mention that OpusCapita focuses its RPA knowledge in financial processes. Keuper (2017) suggests that as RPA develops into intelligent RPA, it can better understand human speech and structured data like e-mails and with these skills automate more complex business processes. He then continues that contemporarily RPA is used in transactions in trade finance, cash operations, loan operations and tax whereas compliance is seen as another branch to utilise RPA.

CGI (2016) licenced an RPA service in 2016 focused on public organisations' needs. This service was advertised to ease routing of purchase invoices, their checking and approval and inputting these invoices into accounting. Other examples of financial administration-related uses of RPA in public organisation are Helsinki’s utilisation of RPA in drawing memos and sending remainders to invoice approvers and Espoo’s RPA project (Helsinki 2017; Helsinki 2017a; Mussalo). Furthermore, Finnish government’s financial shared services centre “Palkeet” has implemented 16 robots into several tasks in HRM and financial services. In financial services, electronic purchase invoice’s numbers are checked by robot as well as updating vendor register and routing accounts payable documents. Accounting team utilises robots in reconciliation of accounting transactions and HRM in filling absence information among others. (Palkeet 2018).

4.3. Challenges of RPA

As mentioned, robots can only execute rule-based tasks that are well defined and have no to little exceptions. Therefore, they are not suitable for tasks that lack recurring patterns, require creative thinking or have high variability (Asatiani & Penttinen 2016, 69; Zardakis et al.2016). Continuously changing software environment will also be challenging as the robot will then have to be adjusted to the changed software (Slaby & Fersht 2012, 6). Literature has found RPA to include at least following risks: security breach, creating unemployment and human taught errors (Slaby & Fersht 2012, 11-12; Hodson 2015; Lacity et al. 2016). Robots have also been problematic to compliance: at least one company has even had problems deciding what gender the robots belong to (Boulton 2017).

The effect on required labour force is to some extent dubious: Lacity & Willcocks (2015; 2015b, 5) mentions that the companies they have been in contact with haven’t sacked own workers but at the same time they have reduced rental work and avoided hiring new workers. There has been both a case where RPA implementation has increased FTEs onshore and reduced some work offshore (Lacity et al. 2016, 28-29) and a case where both onshore and offshore employee amounts haven’t changed (Lacity et al. 2015b, 13). Willcocks mentions in an interview in YLE (2016) that RPA will not likely bring much workforce back from outsourced countries. Del Rowe (2017) argues that claims of RPA making human workers obsolete is baseless. Then again, Hodson (2015) considers it possible that RPA, or at least future AI products, may reduce required labour force, and create inequality as RPA takes away those very jobs that are usually the first ones new-comers will receive. Both Asatiani & Penttinen (2016, 70) and Slaby & Fersht (2012, 1) see that RPA will reduce the need for offshore outsourcing thereby reducing required work force. It would sound likely, though, that RPA also creates new jobs due to its programming, maintenance and other needs. Indeed, City of Helsinki (2017, 122) has noted that due to automation they will need all in all less labour force but at the same time RPA requires more professional workforce to deal with it.

When it comes to security, Hodson (2015) and Del Rowe (2017) write that RPA actually increases security. Indeed, because the robot has a user account and password, there is no more worry about security breaches than with human workers. (Hodson 2015; Lacity & Willcocks 2015; Garberg 2017, 37). Lacity et al. (2016, 22) come to same conclusions also emphasizing that the robot has its own account and password. Robots also never misuse data they receive (Del Rowe 2017).

Another risk is that robots are not intelligent, so if they are taught wrong, they will keep doing the wrong process until human notices the fault. One such case is mentioned by Boulton (2017): in one company an employee changed the firm’s password, but no one informed the RPA provider about this. The robot wasn’t provided the new password and the work it should have done was lost. The quality of the data can limit RPA’s usage too.

Implementation of the RPA may also be challenging. An organisation may not have adequate strategy to utilise RPA to its full potential. Per Lacity et al. (2015a, 30-33), the organisation should focus right personnel to concentrate on implementing the RPA into certain tasks that need to be thought thoroughly. Indeed, otherwise there is a possibility that RPA is implemented into tasks that do not suit it or the tasks are right, but the robot is not taught in a way that it can unleash its full potential.

4.4. Alternatives of RPA

The very aim of robotic process automation is making processes flow more efficient. Its alternatives can be automating solutions or using manual labour if it is more practical. Emphasis has been put at least on speed, accuracy and price when comparing RPA with its alternatives (Lacity et al. 2015a;2015b;2016; Slaby & Fersht 2012; Asatiani & Penttinen 2014). The alternatives this chapter presents are IT-related business process management/service-oriented architecture known together as heavyweight IT, “screen scraper”, coding in UI known as lightweight IT, outsourcing, cognitive automation, social robotics and improvement of e-invoicing.

Per Slaby & Fersht (2012) and Lacity et al. (2016), RPA has become both an alternative and a complement for BPM and SOA solutions. While RPA is lightweight IT, BPM is "harder" and more classic as it does not change front end UI but the deeper layers (Slaby & Fersht 2012, 5; Lacity et al. 2016, 24). Penttinen et al. (2018, 2-3) conclude that both light and heavy weight IT require stable, i.e. non-changing, system architecture to use either one. In back-end "heavyweight" IT stability is required from data access and application layers and API whereas "lightweight" IT requires stability of user interface which it uses for data access. The difference between the RPA and BPM is further elaborated by Forrester research (2014, 3) so that BPM modifies process, RPA automates an existing process and BPM creates new application whereas RPA uses existing application. As BPM changes systems like ERP system, there is a risk that changes in one program can affect other programs negatively since API may change. (Lacity et al. 2015a, 6-9). Slaby & Fersht (2012, 5) has also compared BPM and RPA and concluded that BPM/SOA solutions require highly skilled and highly experienced IT-experts compared to RPA that requires analysts and process modelers with a few months RPA training. They further emphasise that the development methodology of BPM is rather complex as application-layer integration is required in many tasks. Slaby & Fersht (2012, 6) argue that BPM development made by IT-professionals is better suited for strategic changes in a company whereas RPA is more tactical. Due to its complex nature, BPM can be more expensive than RPA. Slaby & Fersht (2012, 10) discuss a case where it would have cost IT department using BPM development 800 000£ and 1 year to accomplish the case whereas RPA required six months and 80 000£ plus annual license payments of ca 100 000£. However, Asatiani & Penttinen (2016, 68) argue that changes to API are nevertheless superior way to increase automation via machine-to-machine integration despite its complexity compared to RPA.

To further compare RPA and back-end system automation solution, Penttinen, Kasslin & Asatiani (2018) have written an article about the matter including a case study. Lightweight solution RPA has made it possible to create interfaces between systems otherwise too complicated and expensive to automate. However, Penttinen et al. argue that when transaction volumes are extremely high, RPA is inferior to heavyweight IT. Their first case involved checking product availability from different locations within a software. In this case, RPA was chosen over back-end automation because it was faster to implement and cost much less. Indeed, it was even estimated that back-end automation in this case was barely possible, at least with existing systems. The second case was a swivel chair process where tasks included opening email, downloading Excel from it and using Excel information to fill CRM system. RPA could conduct all of them and its implementation took eight months. Back-end automation would have required system changes from customer company too to integrate systems as well as changing mail system and replacing Excel with another document form. RPA was also found more agile solution which was important factor because the target company believed that the process will likely change in the future. Even though both examples were more suitable for RPA than heavyweight solutions, Penttinen et al. list characteristics where they find the latter solution better: there is only one system involved, process volume is huge, back-end system remains stable, APIs are already present, no need to hurry, process is permanent, IT resources are high. (Penttinen et al. 2018, 1-11).

Penttinen et al. (2018, 4) mentioned other lightweight solutions beside RPA: macros and scripting. The already mentioned Excel has this macro option: VBA. Indeed, Moffitt (2018, 2-4) compare RPA to precisely Excel macros but also argue that macros may be better fitting for reconciliation of accounts whereas RPA should be used to importing and exporting data. Macros can be used inside Excel to record or chart commands there. VBA does not change the API of Excel though but only affects UI, i.e. data in Excel sheets. (Moffitt et al. 2018, 4). There is no way for the VBA to automatically import information from other than Microsoft software though. A solution to this has been offered from at least 2006 onwards – and the solution is precisely the RPA per Tethys Solutions / Automation Anywhere (Excel Forum 2006). The final UI-utilising solution discussed in subchapter “Repetitive task automation solutions for financial administration” was “screen scraper” which was dependent on data being in same coordinates in screen. RPA is not based on coordinates but instead searches data fields.

Zarkadakis et al. (2016) offer in their article two automation solutions beside RPA (indeed, the third way mentioned in the header is precisely the RPA). One alternative was cognitive automation and the other was social robotics. Zarkadakis et al. (2016) consider RPA to be the simplest and most “mature” of the three automation alternatives. Whereas RPA focuses on routine tasks with low complexity, cognitive automation focuses on exploratory and creative tasks with high complexity. Social robotics can perform both routine tasks like RPA and complex tasks like cognitive automation. Being physical, its strength is better cooperation with humans. Zarkadakis et al. have also made a table combining the features of the three automation alternatives while working at Willis Tower Watson. The table is found as appendix 2. One can observe from the table and from the previous paragraph that the two other robotic solutions differ from RPA in many respects. Whereas cognitive automation differs from RPA substantially, the tasks executed by social robots and RPA can be similar but even they differ in price and implementation time RPA being both cheaper and faster to implement. Their main differences seem to be the more physical nature of social robotics, its connection to collaboration and, apparently, less rule-based learning style.

Slaby & Fersht (2012, 1) mention outsourcing as the very alternative RPA is compared to. Everaert, Sarens and Rommel (2008, 108) suggest that, based on their survey, low transaction volume accounting is most likely to be outsourced. The popularity does not necessarily equal best practice for company, though. Slaby & Fersht (2012, 1,11) estimate the cost of an offshore worker to be some 40% of an onshore worker – and that robot costs half of that while also doing on average a work of 1,7 human labourers. Asatiani & Penttinen (2016, 68) estimated offshore worker to cost almost half to one fifth of an onshore worker and that one robot costs the same amount as two to three offshore workers. Furthermore, Slaby & Fersht (2012, 1-6,11) argue that using offshore labour requires training them, managing integration of business cultures, security issues, dealing with domestic unpopularity of sending jobs abroad and possibly exchange rate risks.

It has been estimated that fully automatic e-invoice may costs less than tenth of paper invoice. Especially if received invoice matches existing order number or contract, it may require no manual, or alternatively robot-based processing. (Lahti & Salminen 2014, 52-59; Penttinen 2008, 4). Therefore, organisations could benefit from increased use of this invoice type and could demand them as often as possible. However, it is likely impossible that organisation can make all acquisitions from vendors with them they have such contracts, so RPA may not have to compete with this option but to supplement it: invoices that cannot be fully automated with e-invoice plus suitable ledger software are then directed for a robot to complete. In addition, demanding certain standards and information from invoices benefits both solutions as Lintukangas (2017, 71) and Lahti & Salminen (2014, 68) argue. Interviewee 1 also pointed out that RPA can read pdf unlike invoicing software that reads only XML.

5. Case: RPA in Vantaa's Financial Shared Services Centre

This chapter includes the empirical research in the case organisation. There is a single organisation, Vantaa, whose financial administration is scrutinized. The actual case focuses on Vantaa's financial shared services: what are its tasks, how it handles them and where and how it has utilised robotic process automation. A more detailed information on the case city is provided in following subchapters. This chapter consists of findings from interviews, background information of the case organisation, explanation of methodology and assessment of reliability and validity. A comparison to other cities' financial administrations as well as other comparisons and valuations, are made in subchapter "Results and analysis of the case".

5.1. Methodology and data

In the introduction chapter, it was mentioned that this is a case study utilising qualitative methods. As the study is qualitative and requires deeper knowledge of how RPA has been utilised so far, an interview was chosen as the most proper method. Two interviews were conducted for this thesis. The first one was the "main" interview and the second one supportive interview because the first one was much longer and handled RPA project thoroughly whereas the second one was shorter, and its main purpose was to verify findings made from the first interview and Vantaa's public material. Moreover, to support this study, empirical observations of the robot and the tasks in financial administration have also been made by the writer of this thesis. Basic information about administration costs, especially in the field of financial administration, is gathered from Vantaa's BI and ERP software SAP. The writer of this thesis is also familiarised with invoice circulation software Rondo.

The interviews were chosen to be semi-standardized. Per Vilko (2016, 20), standardized interview should have pre-defined questions and pre-defined answers to them, and the conversation should be limited into answering these questions. Even though the interview questions were pre-defined and commonly expected certain kinds of answers, the interviews were closer to unstandardized as the interviewees could answer the questions freely and explain their ideas on RPA and accounts payable process. This applies especially to the first interview. Themes were chosen in advance and were based on theory, so the interview was semi-structured rather than wholly unstructured.

The first interview was conducted and recorded in July 2018. The questions asked are gathered in appendix 3. They were chosen based on how well they would help to answer the research questions. Other questions would also have an answer in literature apart from questions 10 although Penttinen et al. (2018) handled a situation impossible for BPM. Questions in English and their contact to literature are presented in table 6. The answers are summarised in chapter "Situation after RPA implementation". The interviewee 1 is RPA project's coordinator in City of Vantaa's financial shared services centre. She plans what kind of tasks are implemented and how they are implemented for the robots. The actual robot programming is done by an employee of the RPA distributor company. She has been part of the project from the early stage. Interviewee 1 is also referred to as Vantaa's robotic expert and head of RPA as her job is centred into RPA matters.

The second interview was executed later, and its purpose was to verify whether the capabilities of the robots were understood correctly and to gain more detailed knowledge on financial administration in Vantaa. This interview was done via e-mail and included ten questions that handled both RPA project as well as accounts payable process in general. The questions are presented in appendix 4. The interviewee 2 is accounts payable team's leader and has taken part in the RPA project from the beginning. She is also sometimes referred to as head of accounts payable team. This second interview is later always called interview 2 whereas interview 1 is called either interview 1 or simply interview.

Table 6. Interview questions and literature where respective answer could be found.

Question	Literature
To what tasks is purchase invoicing divided into?	Penttinen 2008; Lahti & Salminen 2014
Have all teams in Financial shared services adapted RPA?	Helsinki 2017, Palkeet 2018
What is the cost of a single purchase invoice?	Penttinen 2008; Lahti & Salminen 2014
What was the pre-RPA solution?	Slaby & Fersht 2012; Lacity et al. 2016
What aims were set to RPA and have they been achieved? E.g. % of invoices handled by the robot?	Lacity et al. 2016
Has there been changes in personnel amount, has time been saved and have mistakes reduced?	Lacity et al. 2015a; 2015b; 2016; Asatiani & Penttinen 2016; Forrester Research 2014

What problems have the robots faced?	Boulton 2017
What kind of service model does the RPA vendor provide? What kind of pricing do they use?	Lacity et al. 2016; Asatiani & Penttinen 2016
If some problem occurs 5 times a day, is it profitable to automate?	Asatiani & Penttinen 2016; Lacity et al. 2016
Can a robot read invoice information that is unreadable for invoice software?	N/A
How much does different tasks cost?	Penttinen 2008; Lahti & Salminen 2014; Espoo 2017
What kind of invoices are impossible for invoice software to handle?	Lahti & Salminen 2014

5.2. Expenses of financial administration in Vantaa

This subchapter handles the general state of financial administration in Vantaa as well as its finances and the proportion of financial administration compared to whole organisation's budget. City's organisation is also introduced to better understand terms used in the next subchapters.

Although this case study focuses on financial administration tasks in financial shared services centre, it has to be mentioned that Vantaa has not concentrated all financial services into it and departments of education, health and social welfare, and land use, building and environment have their own financial and administrative service branches. (Vantaan kaupunki 2017, 81,101,132). Therefore, to understand financial administration in Vantaa, the city-wide financial administration is introduced. Vantaa's organisation is divided into wholly owned subsidiaries and the city itself. The city is further divided into departments ("toimialat"), divisions ("tulosalueet") and cost centres ("kustannuspaikat"). The departments handle some financial administration tasks. For example, in educational department the employees are responsible for department-related invoice booking and approval, sales and travel invoices, guiding personnel with financial matters and monitoring, forecasting and planning of financial information. (Avain 2018a). Group services includes financial shared services centre, purchasing centre, financing and IT administration branches. Financial shared services centre is the main performer of financial tasks. Indeed, this centre handles at least partially all sales and purchase invoices and up to 90% of other financial administration tasks.

Accounting and collection activities of all departments are concentrated in financial shared services centre too. (Vantaan kaupunki 2017, 72).

Annual budget for the entire city is presented in table 7. Table also includes administration's or financial administration's size. The combined budget of the whole administration has ranged from 0,53% to 1,45% in 2018 depending on the department (Vantaa 2017, 70,78-81,98,132). In most departments, financial services are further divided from other administrative services and constitute less than 20% of whole administration's budget. Citywide financial services form less than one percent of net costs. (Vantaa BI 2018b). The budget for financial shared services is 3,69M€ in 2018, a decrease of some 40 000€ from previous year. At the same time, the estimated income of the department has increased by 10 000€ further decreasing the total expenditure margin to 2,74M€. (Vantaa BI 2018). Financial shared services centre is divided into four teams: accounting, accounts receivable / sales invoice, accounts payable / purchase invoice, and invoicing (Vantaa BI 2018, Avain 2018).

Table 7. Margins of Vantaa's departments and financial services share within departments. Land use, Building and Environmental Department has not made division between financial and other administration. However, in previous two departments financial administration has formed some 10-15% of all administration costs and Land Use Department could well follow same logic changing the value to some 0,1-0,2%. (Vantaa BI 2018b).

	2016	**2017**	**2018 est.**
Department	**1000 EUR**	**1000 EUR**	**1000 EUR**
Vantaa	-993 119	-1 010 446	-1 085 785
Financial services	0,5 %	0,4 %	0,5 %
Management group	-24 107	-24 231	-26 400
Mayor's department	-15 195	-15 202	-17 781
Group and Citizen Services	-64 305	-72 092	-79 790
Financial shared services	4,0 %	3,5 %	3,4 %
Health and Social Welfare	-569 184	-556 178	-579 062
Financial administration	0,1 %	0,1 %	0,2 %
Education	-394 315	-398 107	-440 328
Financial administration	0,1 %	0,1 %	0,1 %
Land use, Building & Environment	73 988	55 364	57 575
Administration	-1,4 %	-1,6 %	-1,9 %

One employee in shared services is expected to handle some 27 900 purchase invoices in 2018 whereas the amount was 23 438 in 2015. Same numbers are 43 700 and 39 530 respectively for sales invoices. Outside shared services an employee handles on average 8338 purchase invoices or 7118 sales invoices, although his/her job may involve more other tasks too. Accounting department is expected to require 9,7 full-time employees 2018 while three years earlier 11,8 employees were required. (Vantaa 2017, 75). As one can observe, the work has become less labour intensive over the period. Moreover, based on numbers mentioned, concentration has been an efficient solution. Figure 5 exhibits the trend of working margin, i.e. income's and expense's subtraction, in financial shared services' teams. Namely invoicing, accounts receivable, accounts payable and accounting activities. Apart from accounting, a slight increase in expenses has occurred. The proportions of these teams were 32, 26, 28, 14% respectively in 2017.

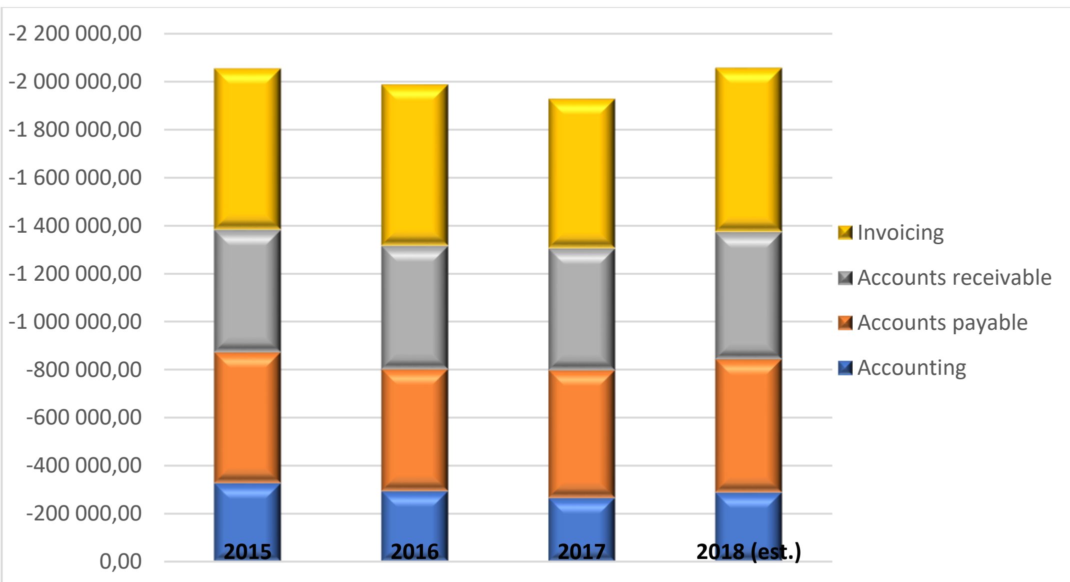


Figure 5. Financial shared services centre's operating margin (profits-expenses) for financial administration teams: invoicing, accounts receivable, accounts payable and accounting. Notice that the values are negative, i.e. expenses surpass incomes. (Vantaa BI 2018).

5.3. Empirical findings from Vantaa's RPA project

This subchapter presents the stage of accounts payable process and robotization in case organisation. Results are based on question and their respective results from the interview. The chapter is divided into situation before and situation after implementation of software robotics.

“Situation before RPA implementation” chapter introduces the situation before robotics was implemented and what kind of solutions were used then. In this chapter, as well as in the whole thesis, purchase invoicing related activities are considered a single process and different parts of that process are called tasks. Purchase invoice process and accounts payable process are used unanimously to refer to the same process.

City of Vantaa has implemented robots only in accounts payable team in August 2018. The project is mainly executed by accounts payable team and the outsourced provider, but the IT unit has been present in provider-related meetings and defining the scope of the project. (interview2). There are plans to expand the use of robots to other fields too, like personnel services. The aim of the project is to help purchase invoice team to handle the increased amount of invoices that has occurred due to the centralization of accounts payable tasks into financial shared services centre. As per the politics of the municipality, the RPA project has been tendered out recently which puts development of the project for a partial halt until the provider of robotics is clear. (interview).

As mentioned earlier, Vantaa is not the first municipality in Finland to implement RPA. Helsinki had started its project before Vantaa and Espoo started it roughly at the same time. Per literature, the tasks into which RPA is implemented differ by city (Helsinki 2017, interview, Mussalo). Vantaa is aware of these projects and what kind of processes they have included. (interview). Vantaa employs two robots. Their task is not to replace any invoice circulation software’s functions but to complement it and perform tasks the circulation software is not able to. The aim is to free labour force to other tasks. (interview).

5.3.1. Situation before RPA implementation

As RPA is expected to decrease manual labour, it should either decrease labour expenses or allow the labour to be used more effectively. City of Vantaa’s financial shared services centre (short. financial services) has had a slight increase in labour force costs every year from 2014 to 2018 (Vantaa BI 2018). The amount of work that needs to be done has increased too, though, as the second paragraph points out. In addition to other material, this chapter will handle interview questions 1-4 and 11-12 of the first interview and interview questions 1-7 of the second interview.

Accounts payable team's budget is ca. 28% of financial shared services' gross budget (see figure 5) and employs some dozen employees (Avain 2018b). Accounts payable team is the first unit in financial services to implement RPA. There have been ideas that RPA usage will expand to accounting at some point in the future. As some part of accounting, namely the booking process, is already conducted by accounts payable team, accounting can be considered to already use RPA. The interviewee considers that the most important part to do before implementing RPA is that organisation maps as precisely as possible what phases those processes have, which are planned to be passed on for robots. She also sees that, ideally, the robot should be given cases that have high volume and are simple to teach to robots. (interview).

Even before RPA, Vantaa had made significant progress in making processes more efficient. Concentrating financial administration to financial shared services centre has, in ten years, led to 97% increase in purchase invoice handlings per employee whereas with sales invoices the increase is even more substantial 666%. Contemporarily, most financial services are already concentrated in financial shared services centre. (Vantaa 2017, 72). The amount of invoices Vantaa city receives annually has increased steadily in recent years: 2015 Vantaa received 270 000, 2016 290 000 and 2017 310 000 B2B invoices and these figures exclude the substantial amount of invoices received from sole proprietors and private citizens (Helsinki Region Infoshare 2017; 2017a; 2018). In the first half of 2018, some 140 000 invoices have already been received (interiew2). The increase in invoices reflects to the budget too: it has risen every year for both personnel costs and services but not as fast as invoice amounts. (Vantaa BI 2018;2018a). The invoices are received via different channels: channel one includes e-invoices without any need for scanning. Channels two and three include paper invoices that have to be scanned with character recognizing scanner and invoices that come via email to outsourcing partner and financial shared services directly respectively. Channel one is most common as almost 90% of invoices come via this route. (interview2). Channel's two and three are more prone to have problems that require manual labour as next paragraph will elaborate. Moreover, for delicate invoices, e.g. ones with people's social security numbers, paper is still commoj invoicing option.

Accounts payable team is, in addition to processing purchase invoices, responsible for answering calls and email related to purchase invoicing and updating vendor information with help from departments' financial personnel. (interview; Vantaa's financial shared services centre's figure).

As previous paragraph pointed out, financial services has outsourced some tasks in the whole process. Namely receiving and scanning paper invoices. These were activities of channels two and three. The private company does these tasks and then sends the invoices to the invoice circulation software for processing. These scanned invoices generally have less relevant information in them making them harder to process automatically. Instead, a lot of information needs to be added manually in financial services.

Figure 6 below presents the whole purchase invoice process. For invoices that are not entirely handled at financial services but partially at departments, purchase invoice team has three tasks: 1. Routing, 2. Final approval, 3. Transfer to ledger for payment. If cost centre, or other relevant identification method, is written in suitable location in the invoice, Rondo can automatically route the invoice. Then purchase invoice team's part consists only of the latter two tasks. Although checking focuses on ensuring that correct VAT is used, there are other information in the invoice that may occasionally have to be corrected: sum, vendor, currency, is the vendor in payment ban, buyer (i.e. is cost centre correct), account, invoice date, due date and presence in prepayment register ("ennakkoperintärekisteri"). Due to policy to concentrate financial administration to shared services, a growing number of invoices is booked there. This means manual input of cost centre, account and right VAT code; a task previously done by departments' own financial employees. A worker, usually superior, in relevant department will still approve the invoice. Therefore, invoices require two checks and approvals. Electric purchase order invoices are exceptions that do not, or at least should not, require checking as "*they come automatically based on order*" (interview2). Finally, accounts payable team member sends invoices to purchase ledger or back to department for correction and new approval.

Accounts payable process has several tasks performed by employees from different departments and units. Even though the next subchapter will introduce robots' part in respective process, their role is mentioned in this paragraph to understand what tasks they can do and who else can perform them. The whole process is depicted in figure 6 made by the employees of Vantaa. The financial stages are roughly as follows:

1. Invoice software, robot or financial services' employee routes the received invoice into right department.
2. Robot checks whether the invoice has certain information slots correct (e.g. right month).

3. Depending on invoice, a human in relevant department or in financial shared services, ledger software (for purchase order invoices) or a robot books the invoice.
4. Employee in financial services or relevant department approves the invoice.
5. Robot makes final check, especially booking of VAT, and reports result.
6. Final checking and approval are made by financial services' employee after which the approved invoices are transferred to accounts payable ledger for payment. At the end of the day, financial services' employee writes down the number of invoices approved. (interview; interview2; Vantaa's financial shared services centre's figure).

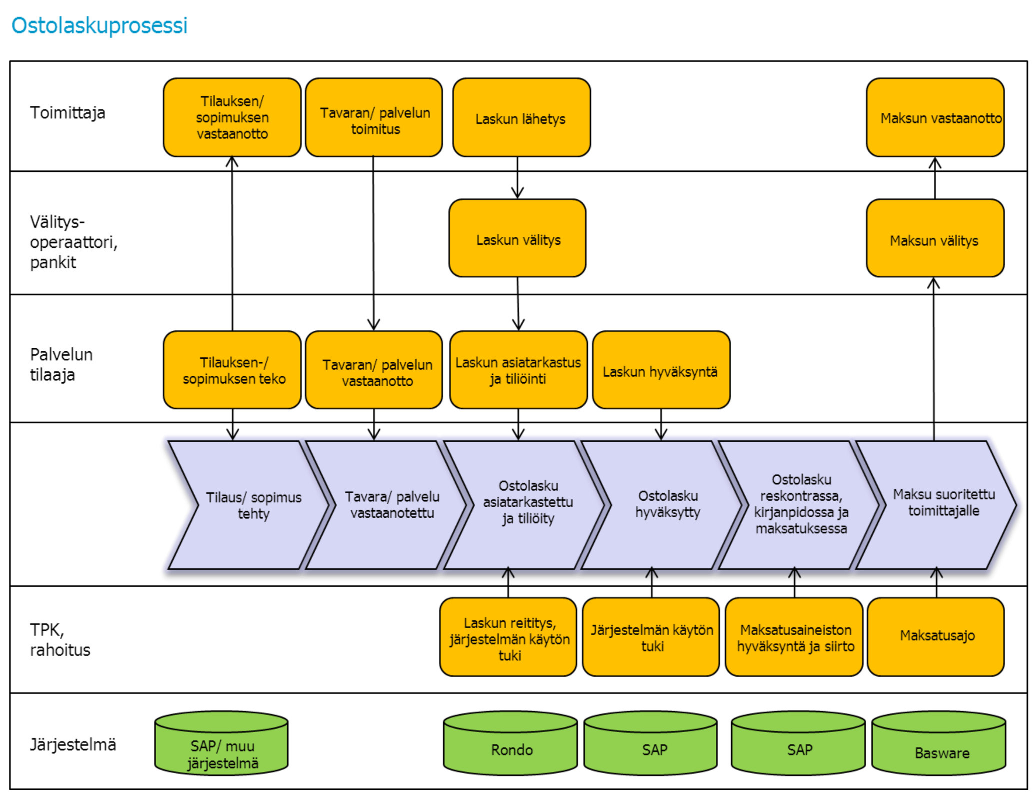


Figure 6. "*Purchase invoice process*". The whole cycle of a purchase invoice. Courtesy of Vantaa's financial shared services centre. The columns, i.e. tasks, in row "TPK, rahoitus" (=Financial shared services centre, finance) are 1. routing invoice, system support, 2. system support, 3. approval and transaction of payables, 4. running payment. (Vantaa's financial shared services centre).

The tasks are not simple and require knowledge of the subject. For example, booking correct VAT requires this kind of deeper knowledge. Based on Finnish VAT legislation, there are different VAT rates and situations where the VAT doesn't have to be paid, i.e. VAT-free business, and situations when an organisation can consider a part of purchase price as VAT even though the deal actually does not include any VAT which is the case in §130a of VAT law. There are also cases were VAT is not deductible and cases where it is returned.

Because the different stages in the purchase invoice process are/were manual, human made errors have constantly occurred. More common mistakes the writer of this thesis faced were the use of wrong account, wrong date and wrong VAT code which interviewee 2 also found most common. Less frequent mistakes were wrong cost centre, which was occasionally difficult to verify though, duplicate invoices, invoices with no sum, empty mandatory information slots and routing to wrong approver. Head of accounts payable team mentions errors in VAT as common reason for correction requirement. She also estimates that dozens of invoices have some sort of problem per day.

Due to it being a delicate matter, the robotics expert cannot reveal precise amounts how much different accounts payable team's tasks cost. Nor are precise numbers provided to her. Inevitably paper invoices and other invoices lacking vital information cost more as they have less potential for automation. (interview). Head of accounts payable team was asked whether the price of processing an invoice is known and she replied that the price is calculated and followed monthly and verified that, unsurprisingly, paper invoices are more expensive than e-invoices. The cost structure of team's tasks is nevertheless clear: there are no material acquisitions related to a single task and therefore the variable cost of a single task is the time it demands from a worker to complete. Additionally, licences, computers and rent of the building could be considered indirect variable costs that do not rise linearly but step by step.

Interviewee 1 estimates that a robot can handle some three to six invoices per minute on average. This includes those problematic cases that the robot can handle. Plain routing takes just few seconds if nothing else has to be done by the robot. (interview). Interviewee 2 had calculated that robots can check some three invoices per minute and deducted that same checking would take longer from human. From the writer of this thesis, checking the department-approved invoices with occasional routing and correcting (i.e. exception handling) required on average some 20 seconds per invoice though this strongly depended on the invoice type. This time was quite on par with interviewee 2's calculation and based on thousands of observations. With salary from chapter "Cost of financial administration in municipalities" and speed mentioned above, some 180 invoices can be approved per hour with the cost of 20€/h or 9 cents per invoice. The price is actually a little lower for approvals since 20€ is the cost for an average-paid worker and 180 is the volume a less-experienced employee handles. This includes only the price of approval and occasional routing which a robot would also do, not the actual price of the purchase invoice process from the beginning to the end. Some innuendo of the entire process' costs can be gotten from Espoo city (2018, 74): they estimated that a purchase invoice costs 6,26€ to handle. One should bear in mind that the robot can work 24 hours a day whereas people work 7,5h minus occasional sick leaves and other work-preventing situations. Therefore, a robot can theoretically check about 4300 invoices a day and a human 1300.

5.3.2. Situation after RPA implementation

This chapter presents what the robots have done and how they have succeeded. This chapter is mainly based on the interviews but also utilises other materiel from Vantaa and some own experience of the writer of this thesis. Interview questions 5-10 and 8-10 from interviews 1 and 2 respectively are handled in this subchapter. Financial shared services centre started with one robot but has increased their amount to two. Robots are not meant to compete with Rondo but work with cases Rondo is not able to automate correctly and that have previously been left for human labourers to execute. Robot's main advantage compared to Rondo is that it can check information from Excel and other external programmes whereas Rondo can only check data from its database. (interview).

According to interviewee, before RPA manual labour was used in the same tasks. The tasks were more and more concentrated from departments to financial services. Therefore, RPA is planned to only reduce human labour and not replace another technology. Contemporarily, the sole swivel chair job robots conduct is checking information from cloud-based spreadsheets, so it does not replace API, and other BPM-related, solutions. There are plans, however, to expand robot into sending notification e-mails to invoice handlers if they have not checked and approved the invoice before due date. Another unit where RPA is considered suitable is HRM. Several tasks have already seen at least some level of automation but, as the interviewee puts it: *"[…] It would be great if they [the tasks given to a robot] are as simple as possible and apply to large volumes which is really challenging because simplicity and high volumes do not sound like something easy to combine – at least when it comes to purchase invoices."* (interview).

The current tasks the robots execute for an invoice are checking if info slots like vendor, reference, or invoice date ("laskun päivä") are empty and presence of "N/A" text in invoice software, routing, possible booking and VAT check. Figure 7 exhibits the order in which robots complete their tasks. (interview; interview2). Interviewee 2 complements that the order of tasks is as follows: in the evening robot 2 starts correctness check ("oikeellisuustarkistus") and soon after robot 1 starts routing and then booking whereas robot 2 will change to VAT checking in the morning thus utilising the whole day. A robot cannot add extra booking rows for example in cases where an employee has used only VAT 24% even when there has been 14% too – it will just inform of this mistake and a human employee needs to correct it manually. For every invoice, robot finally writes into invoice software and online Excel whether the invoice has been entirely correct or has an error been present and to which error category it belongs to. Some flexibility is allowed for the robot: if VAT calculated in the invoice differs a little from the booked VAT, robot is allowed bypass this variation. Robots utilise if statements too: for example, it can allow higher variation between invoice's VAT and real VAT for certain vendors. It cannot, however, know whether VAT is to be returned or deducted ("vähennettävä tai palautettava ALV"). Shortly: based on rules the robot will check the pre-determined information areas one by one and then report errors or everything correct if all is in order. (interview).

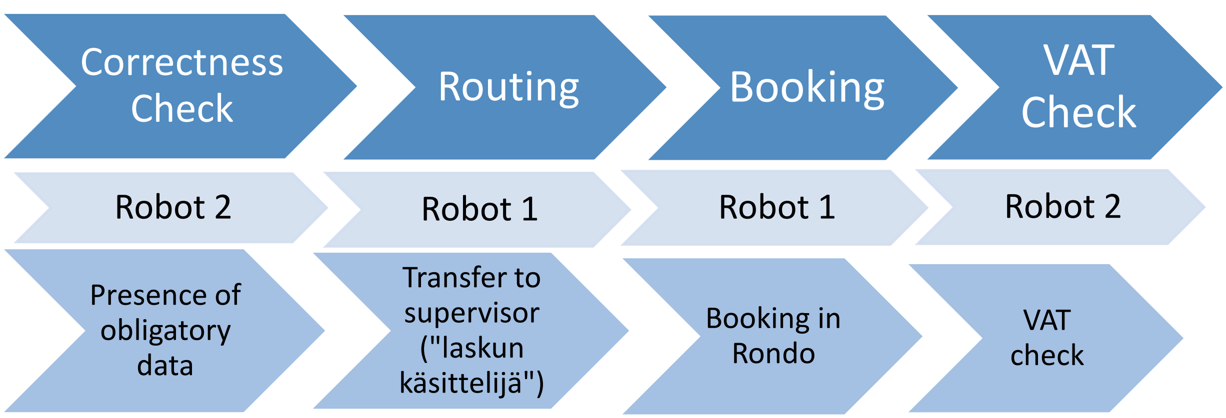


Figure 7. The four tasks robots handle in purchase invoice process per interviews.

Previous paragraph dealt with robots' checking capabilities. Robot can also modify the invoice information in invoice software. (interview2). For certain invoices a robot can also fill information to Rondo: such as VAT information even if it differs from the numbers presented in the invoice. This is most practical when the invoice does not hold correct information from Vantaa's point of view: e.g. in situation where the city cannot legally deduct VAT from payment even though VAT is present in the bill. Often Vantaa can however, in accordance with Finnish VAT legislation, deduct the VAT partially all wholly. To fill missing information into invoice software, the invoice has to be from certain vendors and include a previously registered “identification code/number”. These certain vendors are chosen based on high volume and presence of some sort of identification code. Their amount is currently small though. Previous registration means that identification code, e.g. order number, purchaser number (“tilaajanumero”), and other target-related data, is stored into a cloud-based Excel where a robot can find the information it needs to autocomplete invoice data in invoice software. To sum up, the robot can type in e.g. VAT code, cost centre and account related to a certain identification number as long as this ID number is present in any of the online Excels created for this purpose. Moreover, robot can check from another one of these Excels whether the vendor is in payment ban. Robot can do this faster than human and always recognises these cases. (interview). There are tasks that robots have been found unsuitable to perform, however. Correcting invoice date to match current accounting month (“avoin tilikausi”) was originally planned to be conducted by robots but was cancelled after trials.

The interviewee considers that RPA’s implementation has been in schedule and has gone as expected. The project started in late 2017 with first test in January. The team had no prior robotics experience. No specific numerical goals were set for the RPA, but the idea is that the it should handle as many invoices as possible as soon as possible. However, the interviewee also mentions that the aim was not to gain profit as fast as possible. The interviewee was not informed what kind of measurements were used to monitor RPA performance. As an approximation, the robot autocompleted far less than fifth of all invoices in June. It checks them all through and reports the errors, though, as previously mentioned. Contemporarily, the robot is not able to recognise all errors and the aim is that place them all under certain categories. The RPA implementation is not ready yet but has already saved approvers’ time in financial services. They now have time to focus more on other tasks. (interview). Yet, robots require daily monitoring as they may error and stop working which takes some employee time. (interview; interview2).

The robots have faced problems during implementation face. They are mainly related to lack of data in invoice or invoice data that substantially differs from standard invoices. The robots read XML whenever possible and if XML misses some information – or presents it in abnormal fashion, the robots have to settle with reading the picture which is commonly a pdf. Paper invoices have been especially problematic, or more precisely their scanned versions, as they commonly have less XML text and the invoice picture itself is harder to read for a robot. Some problems are specific to pdf. For example, if in pdf invoice word “VAT” is in upper row and the VAT percent is in lower row, the robot cannot read it. This is because robots cannot see areas like a human but rather reads script row by row. XML never has this problem, but different structures of invoices cause problems to it too: like using point instead of comma. Sometimes invoices even lack certain relevant information completely, e.g. sender is not mentioned in the invoice or a sender has never before sent an invoice. Indeed, the interviewee emphasises that if more invoices used the same standards, both robots and invoice software would be much more efficient. The identification codes help with these problems as RPA only needs to find this code and can then check data from online Excels. This makes robot reliable on online Excels so any mistakes in them will cause robots to do mistakes too. Moreover, if Excels are modified, e.g. the order of rows or columns is changed, the robot may make mistakes. Excel updating is compulsory, though, because invoicing information can change. It would be of great benefit, however, if vendors used same standards in their invoices. (interview).

Occasionally, it has also been challenging to figure out how a robot “thinks”, i.e. understands commands and reads invoices. For example, if postal code is written with a space inside it, the robot may mistake it for internal order number. Robot does not read all information in the invoice: it can e.g. read words “interest payment” and its sum but it doesn’t notice that later in the invoice it is written that this payment is paid only if the invoice is not paid before due date. The robots need to be adjusted often too. For example, if in XML the VAT percent is not written like *<TAX e5283="7" eC241.5153="VAT" eC243.5278="24.0000" e5305="S"/>* but comma is used instead of point, RPA needs to be further programmed to cope with this new type of situation. RPA cannot recognise whether the sender of an invoice is the same organisation as the one who should receive the payment; such instance can happen e.g. when a vendor has sold all its invoices into a finance company. In the future, robots may create new vendor profiles themselves. The interviewee suggests, though, that it is best to leave to human worker the case by case situations. (interview).

The costs of robotics come from many sources. The actual programming of the robot is done by a professional in the robot providing company and his services are charged by hour. In addition, RPA project has a fixed contract cost settled at the tendering phase and annual fee from certain tasks which are paid to the provider. Since robots use the same user accounts as human workers, these account licences need to be paid as well. (interview). External costs are not the only costs arising from robotics. Indeed, the time that the RPA project requires from Vantaa's own personnel is a significant cost too. There are several employees involved in the robotics. The interviewee, who is a specialist in financial administration and its software, is the only person fully devoted into the RPA project. Purchase invoice team's and financial shared service centre's managers as well as several accounts payable clerks spend a lot of time with the project. They attend meetings regarding the implementation, test how the robot has performed and plan how the robot can be implemented to certain tasks or deal with certain problems. (interview).

RPA has variable costs and fixed costs just like human employees. Fixed cost is programming of new tasks; once they have been programmed, no new costs arise from these tasks given that the programming doesn't need further fine-tuning. After the programming has been successfully performed, the cost arising from the task is the time it requires from the robot to complete. The time it takes from Vantaa's employees, apart from the internal robotics specialist, to plan and monitor RPA, can be considered variable cost as the time required is based on amount of tasks taught and the errors in these tasks. Annual robot licences and the salary of Vantaa's internal robotic specialist are fixed costs. Despite the cost related to programming a single task, the interviewee considers that it would be worth to program even tasks/errors occurring only a few times a day should these errors be critical e.g. from legal point of view or have wrong cost centre. At least if correcting them takes minutes from human worker, human worker has an increased chance to make mistakes with the task and the task is possible to be taught to robot. The interviewee estimates that a robot can do up to five different tasks and this amount is mainly limited because there is no more time in a day to conduct more. (interview).

5.4. Results and analysis of the case

This chapter includes analysis of the findings made from the case and discussion about further possibilities of RPA in case company. The current state of the RPA based on interview questions was already explained in chapter "Situation after RPA implementation" and this chapter will compare these findings to literature. Own analysis is also included: this will include gathering findings from the literature to form success factors and discuss the possibilities Vantaa has in expanding RPA and assessing profitability. “Profitability” subchapter will discuss what should be taken into consideration when assessing RPA project’s profitability and performance with case as an example. The “Evaluation and comparison” subchapter will in turn compare findings from Vantaa and from literature to find out whether Vantaa’s case seems exceptional compared to others. If there is substantial variation, one can raise doubt that the current literature may favour successful RPA implementations in their case studies. Another reason for differences may be that public organisations by nature differ from private ones the literature mainly handles. Difference could also mean that this study has some limitations regarding the data that has been gathered, i.e. it cannot measure what it is supposed to, or Vantaa just has been successful. Hopefully, this thesis deepens the current knowledge of RPA’s capabilities in public organisation and financial administration, especially in accounts payable process.

There seems to be a need to further scrutinise what kind and how large costs financial administration has. RPA articles mentioned that it can save workforce and that RPA’s own costs come from development and licences (e.g. Slaby et al. 2012; Lacity et al. 2016). Personnel costs are somewhat easy to calculate if one knows how much work an employee can do but there are some difficulties too: it is hard to estimate sick leaves accurately and how much will the personnel change. Furthermore, it may be important to estimate what share of workforce is fixed and what is more flexible. Team leader is much more fixed than, say, a worker that does volume-based work. Additionally, for some organisation, it can be that it is not possible to employ work force part-time: even if there is a dire need for only half-time labourer a full-time one has to be employed.

Several writers have emphasised that RPA is most successful with high volume and low complexity tasks (e.g. Zarkadakis et al. 2016; Del Rowe 2017), but some have conducted more thorough RPA success criteria listings which could be combined. Table 8 lists success factors created by Asatiani & Penttinen, Slaby & Fersht and Lacity, Willcocks & Craig. Moffitt et al. (2018, 5-7) also list matters an enterprise should consider when RPA is examined, but their scope is limited to auditing. However, they too emphasise existence of common standards, knowledge of processes and that material is available in machine-readable form. The factors created by Asatiani & Penttinen (2016, 69), Slaby & Fersht (2012, 6-7) and Lacity et al. (2015b, 9) describe what requirements a process has, to be suitably for RPA. Slaby & Fersht (2012, 7) emphasise that all these criteria need to be filled for a task to be suitable. On the other hand, Lacity et al. (2015a, 13-35; 2015b, 15-21) focus more on organisational requirements to implement RPA. Furthermore, Lacity et al. (2016, 29-33) have listed success factors for implementation alone called RPA action principles. These principles are: testing RPA capabilities with a controlled experiment first, developing criteria to know which processes are suitable for automation (e.g. mature, long-used), cooperating with IT department, informing employees whether there will be changes in labour force requirements, exploiting new RPA service models like cloud robots and buying only the robot licence vs consulting services too.

Table 8. Success factors of RPA both in process as well as in organisational level.

Asatiani & Penttinen	Slaby & Fersht	Lacity et al. 2015b
•High transaction volume •Use of multiple systems •Non-changing IT systems •No thinking required •Can be described with rules •Little exceptions •Manual task's cost structure is known •No chance for misinterpretation •Substantial human error rate	•High volume/price of transactions •Accessing several systems •Stable IT-system (>12m) •Minor need for human intervention •Clearly definable rules •Little exception-handling need •Understanding of manual costs	•High transaction volume •Rule-based processes •Standardised processes •High process maturity (documentation etc.)

Lacity et al. 2015a	Lacity et al. 2015b
•Define the RPA vision and potential •Fit RPA into existing (pref. centralised) culture and define head of RPA •RPA board to analyse opportunities •Choose consistent RPA delivery type •Clear RPA and human cooperation •Distinct roles and proper training of people •Low maintenance requirements •Strategy to expand later	•Right organisation with head of RPA •Innovation and IT friendly culture •Business-lead, not IT-lead •Standardised, stable processes •Compliance with security policy •Adaptable RPA programming •Teach robots several (/all) tasks •Internal communication

Vantaa has many similarities with the factors mentioned in table 8. Financial shared services centre has used RPA in tasks which can be described with rules and utilised multiple systems to accomplish these tasks: the robots check data from online Excels and compare them to invoice information. (interview; interview 2). Asatiani & Penttinen (2016) and Slaby & Fersht (2012, 5-7) emphasise that the tasks need to have little to none exceptions and Lacity et al.(2015b) recommend that the processes need to be standardised. Vantaa has had more challenges following these factors since invoices have several standards, and therefore several exceptions, and some of these exceptions cannot be defined even with if-statements: e.g. cases where VAT is in two rows in pdf. A slight difference between Vantaa and literature occurs regarding costs. Even though Vantaa is aware of subprocesses' structure and monitor their price, they are not calculating the profitability of implementing new tasks with RPA (interview 2). The current human error rate was not known exactly either, but it was argued that robots do not make mistakes, so error rate has decreased. (interview; interview 2). Nevertheless, some uncertainty of costs remains.

When it comes to organisational recommendations made by Lacity et al.(2015a;2015b), Vantaa is rather close to them. Vantaa has distinct roles for different people including head of RPA, a board that discusses about RPA implementation, challenges and new tasks in addition the board monitors robots' performance and accounts payable employees who continue their traditional jobs. The employments were not identical to Lacity et al. (2015a, 33) which included much more positions. The process is also quite centralised, and the project is business-lead. (interview). As Vantaa's booklet (2017) mentioned, IT department will follow in implementing RPA. The human labourers are aware of their tasks and the ones robots perform making cooperation clear. The city had a strategy for expanding robotics as it was already thought where RPA could be next implemented into. Robots were taught several programmed tasks too. (interview). There were, nevertheless, some organisational differences: consistent delivery type and standardisation of processes - which was hard to achieve given different invoice standards. The literature suggested having consistent RPA delivery type. Vantaa's doctrine for this was rather mixed: per interview, the service model was chosen and had remained constant, but Vantaa has to tender out the provider even though the project is not complete which brings uncertainty whether some procedures have to be executed again with the possible new provider.

5.4.1. Profitability

When assessing profitability, one should recall that there are two types of advantages in classical economic theory; absolute and comparative. This applies to measuring profitability of RPA too. RPA may be profitable compared to manual labour but is it more profitable than all other methods? I.e. does it create the best result as otherwise RPA may not be considered "absolutely" profitable since even more resources could be saved with another method. This comparison can be challenging because it is hard to measure profit of RPA's alternatives or even identify them. A profitability analysis should be conducted to determine whether the implementation of robotics is profitable. This can be in the form of a break-even analysis. If RPA brings more savings (from reduced labour requirements etc.) than are its costs after the implementation phase is over, the project is profitable. If the implementation, i.e. starting, costs are high and the annual savings are low, it will take longer for the project to break even. However, if RPA needs constant updating due to changing systems etc., it may turn unprofitable even though it originally covered all its costs with savings from other solutions. Another situation that reduces RPA's likelihood to be profitable is that robots' work is double-checked by human just like in a case Penttinen et al. (2018, 8) have found. This reduces automated share of a process. Other costs arising from RPA are listed in table 9. If the uncertainty of cost savings is high, one could implement sensitivity analysis and/or fuzzy pay-off to calculate with which likelihood the robotics project turns successful.

It can be hard to calculate exact return of RPA utilisation. Lacity et al. (2015a, 18; 2016, 28-29) have found out a few instances of profit calculation. Some examples of variables to compare between a human labourer and a robot could be number of mistakes, price to handle a transaction, e.g. an invoice, price to learn a new task and also the time it takes to complete or learn a task as well as percent of transactions the robot can handle. Correcting mistake or handling an exception could also be added to the list although both first interview and Penttinen et al. (2018, 8-10) hint that these tasks are not very suitable for a robot. Both Penttinen (2008, 4) and Lahti & Salminen (2014, 59-60) have written about time it consumes to handle e-invoices and paper invoices. Penttinen's figures are 1 and 18 minutes respectively and Lahti & Salminen's 1,5 to 3 and 14 to 26. One could also consider whether RPA can be used as a real option. As real options are providers of flexibility, RPA is more likely to fit into this feature compared to heavy weight IT solutions. The latter change software and are thus harder to cancel after contract is made. For many companies, RPA may not be very suitable real option, though, as the volatility of the costs is not necessarily very high, and real options are best suited for investments with high uncertainty.

As previously discussed in the interview and literature, RPA has mainly fixed costs and turns profitable as the number of units to process rises given that these units had variable costs

(Zarkadakis et al. 2016). In the previous chapter, it was learned, though, that some types of units, namely invoices, were hard if not impossible to process with RPA. Moreover, teaching the robot to do a new task or handle a new type of invoice had one-time costs of programming done by the provider and planning done by the employees in Vantaa. Of course, once this configuration is done, a robot can continue to use it for eternity. It was also found out that teaching did not always provide desired result and even had to be reversed. Therefore, an extra cost of RPA is the redundant-proving planning and programming. More costs were discussed in the end of the “Situation after RPA implementation” chapter. They were the time employees work with RPA project and user account licences of the robots. It is also possible that human worker learns new tasks significantly faster than a robot increasing RPA’s cost compared to humans. If several tasks need to be conducted simultaneously, several robots are needed which means that stepped fixed, or even relatively variable, costs are present. This additional need of robots may be avoided if the robot can execute the tasks one after another. This is likely in financial administration as there is no high-volume simultaneous customer service task mentioned in “Introduction to RPA” by Lacity et al. (2015). One should also estimate whether the costs for RPA are volatile, i.e. can they increase significantly in the future. RPA has also the profit side: it can execute certain tasks faster and cheaper than a human. Indeed, if the robot has smaller costs than a human worker (as per table 5) and executes the tasks faster, it has even higher the chance to be profitable. Table 9 summarises the costs and profits arising from RPA. If loan is taken to pay RPA, then loan’s interest should also be added.

Table 9. Cost and profits arising from RPA based on interviews.

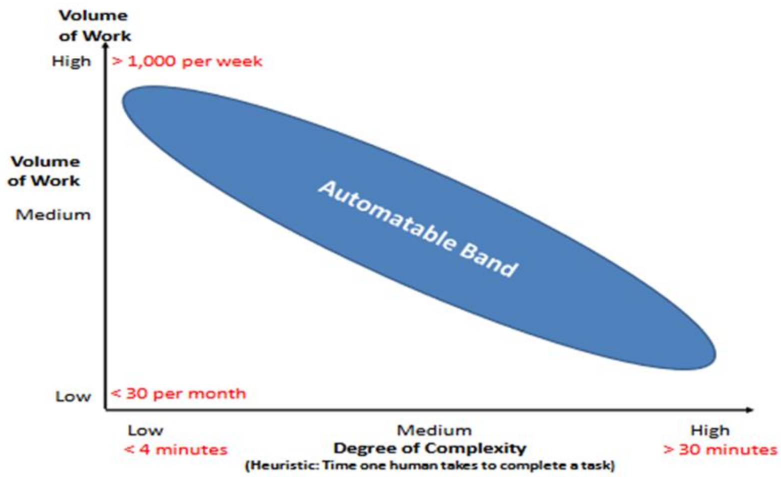
Fixed costs	**Costs of new task**	**Variable costs**
Head of robotics' salary	Programming time done by provider company	Amount of robot licences based on volume
Any yearly contract not based on robot amount	Planning and monitoring by internal personnel	Software accounts based on robot volume
		Monitoring based on volume
Monetary benefits		**Non-monetary benefits**
Time of employees saved	Less mistakes	Employees can respond to questions faster
Faster circulation; less late payment fees	Less instability from labour-force absences	More interesting tasks for employees (satisfaction?)

The simplest method to calculate profitability is likely to compare minutes of work robot requires and minutes of work human requires and these minutes costs. Lacity et al. (2016, 31) have cited rules of Telefonica O2 where they have considered RPA execution to be profitable (see figure 8 below): if the volume is at least 1000 per week and complexity is low, i.e. it takes max four minutes from a human to conduct the task, the RPA is expected to be profitable; the other end of the linear line is that weekly volume is hardly 10 but the respective task takes over 30 minutes for human to conduct. Therefore, the amount of manual labour O2 demands RPA to reduce should be close to 4000 minutes for non-complex tasks but less than 300 minutes for complex ones. This indicates that O2 has some preference towards optimising complex tasks since lower time savings are required from it. Vantaa's robotic expert considered even smaller amounts to be automation worthy when it prevented critical errors (interview).

Vantaa could also apply the previous paragraph's break-even method. As mentioned in chapter "Situation before RPA implementation", a robot can work 24 hours a day and people 7,5h. With this logic, a robot could theoretically check about 4300 invoices a day and a human 1300. Vantaa received on average little under 900 invoices per weekday in August (interview2), so a robot can save some 900/1300 x 7,5h = 5h 20min a day of one FTE's time. In a month, these savings increase to 20000/1300=15 whole days which is over 2/3 of an FTE. Even with this amount, a robot would still have used only some 16% of its potential working time and can perform other tasks too. FTE's, in this case ledger employee's, cost was expected to be some 2990€ with side costs per KVTES (2017) and two thirds of this is 2000€. Therefore, if a software robot would execute this task alone, it should cost less than 2000€/month; otherwise it would be better to use human labour. This cost is reduced if the volume of invoices increases, just like the literature argued (e.g. Lacity et al. 2016). It is noteworthy, though, this example does not consider cases that a human can handle but a robot cannot: i.e. many of these 20000 invoices have such quality that a robot can't handle them. If payback-period is calculated in addition to the break-even analysis, Vantaa should consider all the remaining cost items listed in table 9.

Figure 8. Telefonica O2’s profitability calculation by Lacity, Willcocks & Craig (2016, 31).

Figure 5: O2’s Assessment of RPA Suitability



For the city of Vantaa, the goal of RPA was not to reduce the amount of workers but to free workforce to concentrate on other tasks. (interview). Such situation is also found in literature: Lacity et al. (2015b, 5) mention a company that used RPA to improve existing processes without reducing the number of people. Without RPA it would have been possible that more people were hired in either Vantaa or Lacity et al.’s example. Therefore, RPA possibly reduces cost by preventing the need for hiring new people, outsourcing or increasing overtime work. A more direct effect, mentioned by the interviewee is that now employees previously doing the tasks of the robots have time to do other tasks robots cannot perform, e.g. answering accounts payable team’s mail. This can increase satisfaction of stakeholders as their mails are answered faster. Vantaa could also at some point do an employee satisfaction survey to find out whether robotics has increased job satisfaction. Employee satisfaction has been mentioned in literature, too (Del Rowe 2017). An important characteristic of RPA is also that when it is taught correctly, it abolishes all human-made mistakes. This is potentially an important factor, as mistakes can cost money in many ways. Correcting them takes time and time has a cost; if not direct then at least a human or a robot could have done something more productive with the same time. Moreover, same bill can be paid twice, or a non-legitimate bill is paid, both being especially costly when occurring with a very expensive bill. It can occur, too, that too much is paid – or too little and, in addition to worker’s time, late payment fees have to be paid. Late payment fees should be avoided. They are completely unnecessary part of business and RPA remainders should also be used to reduce them. Late payments do not necessarily occur because of errors in financial shared services: approvers in departments may forget to approve invoices in time.

In addition to evaluating whether it is more profitable to use RPA than current procedure, one should also compare RPA with other automation solutions, i.e. is RPA absolutely profitable. For example, is RPA more profitable than demanding higher amount of e-invoices or using BPM. Lahti & Salminen encouraged as high implementation of e-invoices as possible and e-invoices cost-reduction potential was discussed by Hernandez-Ortega (2012, 16) and Penttinen (2008, 4) too. Indeed, if all invoices were e-invoices, there would be less manual routing, booking and typing other types of data into invoice software and therefore less manual labour with existing technology would be required which leads to savings as interview also emphasised. However, even e-invoices, apart from purchase orders, require manual checking and approval and usually booking too (interview). Hence e-invoices cannot fully automate invoice circulation unless their correction checks are deleted which in turn increases error amounts. Interviewee did not mention coding or other heavyweight IT solutions as alternative for RPA. The literature presented mixed results when choosing heavy IT over RPA: Asatiani & Penttinen (2016, 68) suggest API changes as superior solution to RPA whereas Lacity et al. (2016, 28) and Slaby & Fersht (2012, 10) found a case where RPA had significantly lower payback period than deeper layer PBM solution. And both argued that RPA does not have to be seen as an alternative but a complement to BPM. Penttinen et al. (2018, 8) have also examined a case where heavy weight IT was significantly costlier than RPA.

5.4.2. Evaluation and comparison

This chapter compares arguments made in the literature to findings from the case study. Emphasis is put into comparing matters, such as implementation, tasks where it is used and ROI, between literature and in Vantaa’s financial shared services centre. Results in financial administration are also compared to results in other tasks. This can give some innuendo whether financial processes are well suited for RPA as e.g. Slaby & Fersht (2012, 5) claimed. Furthermore, automation and accounts payable process are compared between Vantaa and literature.

There have already been ideas in literature how to estimate RPA’s suitability for an organisation as well as ideas how to estimate processes suitability and profitability. Such are made by Lacity et al.

(2016, 26-27) and Lahti & Salminen (2014, 179-180) respectively. The questions are listed below. Lahti & Salminen's questions are suitable for finding out the current costs, performance and structure of invoicing as well as for projects in general. Indeed, both Asatiani & Penttinen (2016, 69) and Slaby & Fersht (2012, 6-7) have emphasised that cost of process to be automated should be known as mentioned in table 8. Lacity et al.'s question one is already answered by literature: RPA interferes only with user interface (Hodson 2015; Asatiani & Penttinen 2016, 68). Questions two and three, on the other hand, can be scrutinised with results in table 10 and to some extent with answers to interview questions 5, 6, 7 and 10.

Lacity et al. (2016, 26-27) cite O2's questions for implementing RPA:
1. *"Will RPA integrate with O2's systems of record without breaking them?"*
2. *"Will RPA technology provide quality services?"*
3. *"Will the technology provide enough of a return on investment?*"

Lahti & Salminen (2014, 179-180) provide potential units to measure in a report:
1. Project report: income, expense, profitability, time consumed (compared to plan).
2. Purchase invoice report: monthly volume, volume by cost centre, approvals per worker, purchases by vendor.
3. Accounts payable ledger reports: volume of unhandled invoices at the end of the month, unhandled invoices by vendor, volume of expired invoices.

It is hard to compare Vantaa's financial results to other cases of RPA implementation because Vantaa did not provide ROI or payback period. Naturally this is almost impossible as the implementation phase is still ongoing. Most relevant comparisons for Vantaa would be cases where RPA is applied into financial administration tasks. Especially if these organisations had rather same size of financial administration, both absolutely and proportionally. Espoo and Helsinki might be most suitable organisation to compare with as Espoo even had similar cost structure of financial shared services when it came to purchase and sales invoices: circa 25% and 20% for Espoo and 26% and 28% for Vantaa. However, as chapter "Examples of RPA" indicates, financial administration-related case studies are scarce. This is rather disappointing because RPA is meant to reduce costs and as a support activity, reducing financial administration costs should not affect organisation's product/service quality. Vantaa's core business is not financial administration but educational, social and welfare related matters and Vantaa has litlle sales. Indeed, Lacity et al. (2016, 34) mentions 13 examples of RPA utilisation none of them handling invoicing, one corporate earnings report, one mortgage lending and savings and one payroll verification. Tasks that are considered part of financial administration were listed in table 2 and appendix 1. Literature examples with calculated ROI are presented in table 10. In a process level, RPA's transaction handling percentage could also be calculated: Lacity et al. (2015b, 13) have found this to be 93% in one case. One should bear in mind that literature may have focused on the cases that have been most successful with RPA. Indeed, Moffitt et al. (2018, 9) cite a finding that 30-50% of RPA projects end up unsuccessful. Because there are only few instances where some sort of ROI is measured, drawing conclusions based on them is hard. The first two cases are not mentioned to include financial processes listed by Lahti & Salminen and Asatiani. These cases were, however, the most profitable ones which mildly suggests that general back-office tasks can be more suitable for RPA than the latter three cases with financial processes. The number of observations is nevertheless so low that any significant conclusions cannot be made. One should remember too that certain financial processes are much more suitable for RPA than others. Indeed, process characteristics, e.g. rule-base, matter more than business process' field.

Table 10. The business area, task, implementation time, transaction amount, whether RPA works between different software, pay-back period and ROI of RPA examples. Numbers and their references are: 1. Lacity et al. 2016, 2. Lacity et al. 2015a, 3. Palkeet 2018;2018a, 4. Helsinki 2017a, 5. Lacity et al. 2015b.

Business Area	**Tasks**	**Implementation time**	**Transaction volume and % of all tasks**	**Between-software "swivel chair" tasks**	**Payback time**	**ROI and time it's achieved**
O2. Back-office generally [1]	15 processes. Among them copying old SIM number to new one, adding pre-defined credit to customer account	3 months. (Then own personnel continued programming)	400 000 - 500 000 (160 robots) 35%	Yes	Possibly 10 months	650-800% (three years)
Utility. Business ops. [1,2]	Reading applicability checking		1 000 000 35%			200% (one year)
Xchanging. Business ops. [1,2,5]	14 processes. Insurance-related. Premium advice notifications among others		120 000 (27 robots)			11-30% /process

Palkeet. Financial administr ation and HRM [3]	Several: at least e-invoice routing and number checking, updating vendor registry, personnel absence data		(16 robots)	Yes		20% increased efficiency (with other automation solutions)
Helsinki. Financial administr ation [4]	Approval reminders, invoice basic information scrutinising	(Started 2016; ongoing)				>0,1 FTE & reduced late payment fees

Some comparisons between literature and findings in Vantaa can be made despite the project being ongoing in Vantaa. Several sources estimated implementation of RPA to last from weeks to few months; this usually including that personnel have learned to operate RPA independently (Slaby & Fersht 2012, 5-7; Asatiani & Penttinen 2016, 68; Lacity & Willcocks 2015). Per interview, Vantaa has been occupied with the RPA project from late 2017 and the robots are still partially in the testing phase although robots have been executing pilot tasks for some months. If Vantaa's tasks are more complicated than the ones in literature's examples, the difference in project lengths can be explained. Moreover, literature mentions the minimum durations they have encountered: for example, it took Xchanging nearly a year to automate first four processes (Lacity et al. 2015b, 10). However, automating next processes should be faster per Lacity et al.'s (2015b, 13) findings. Either way, a new employee could have learned these tasks faster, but human workforce has some risks robots do not as they may change job, have sick leaves etc.

Table 10 also exhibited that many organisations have employed more robots than Vantaa's financial shared services' two units. Slaby & Fersht (2012, 7) and Lacity et al. (2015b, 15) recommend implementing RPA to a few pilot processes first and then expanding to more processes. This has been the case in Vantaa too since they have chosen VAT checking and purchase order handling as pilots and there are plans to expand RPA to new processes (interview). Helsinki city and Palkeet are both public organisations that have also implemented RPA into financial administration and therefore Vantaa city's case is most likely more similar to these two than the ones Lacity, Willcocks and Craig have scrutinised. Therefore, Vantaa's expected savings are best compared to the last two cases in table 10. Another thing that Vantaa has done same as literature is the department RPA is implemented into. Lacity et al. (2015a, 3) suggest the implementation to tasks that are either centralised or outsourced just as Vantaa had decided too.

The literature has only once hinted to a situation where one department of an organisation, that had already utilised robotics, helped another one with robotics. This short mentioning is made by Lacity et al. (2015a, 34-35) and they offer as explanation that the early adopters of RPA saw it only as a tactical tool. This kind of cooperation could provide vital experience even though the tasks where a robot will be implemented differed much. Indeed, other units have even been close to a hindrance as in one case IT unit was originally highly sceptical towards RPA (Lacity et al. 2016, 27-28).

Volatility in data quality and presentation can be a problem to an organisation such as Vantaa. E-invoice may not suffice to automate the whole circulation of an invoice because data is so diverse and some vital information may be lacking, such as VAT percent as interview indicated. The same finding about data complexity was also made by Lintukangas (2017, 71). Other literature has written much less about the matter. Lacity et al. (2016, 28) provided an example of profitable RPA implementation in O2. This enterprise had the RPA provider teach internal employees to independently program the robots. Vantaa did otherwise, and all programming is done by the provider's specialist whose seat is not in Vantaa's offices either. Vantaa's RPA-related organisation is yet rather close to the optimal RPA organisation mentioned by Lacity et al. (2015a, 33): even though the developer is not an internal employee, such distinct role exists. The developer has also to some extent the role of service analyst. Process analyst, i.e. robotics expert, charting processes is present but instead of one, there are a few people testing and administrating the project even though Lacity et al. refer to single distinct persons executing each of these.

In addition to robotics, a comparison between automation in literature and in case of Vantaa is made. As was observed in theoretical part, Lahti & Salminen have written a lot about automatization of financial administration and included Finnish perspective in their book. The tasks in accounts payable process were very similar to those executed in Vantaa which makes it easier to compare automation solutions for the two (2014, 66). Lahti & Salminen (2014, 58) mention that direct procurement with purchase orders are so far the most automated branch of purchase invoices. They further estimate that contract-based repeating invoices have increasingly been automated too. This holds also for Vantaa city (interview). While purchase order invoices are automated with Rondo, contract-based ones are now handled by a robot. Lahti & Salminen (2014, 58) mention that the rest of the invoices should be automated as far as possible with invoice information. Both interviewee and Lahti & Salminen (2014, 60-61) mention that such information has to include cost centre and/or the buyer to enable at least some sort of automation. In Vantaa, this would at least help with routing. In Vantaa's case, Rondo doesn't have to perform all automation, but RPA can help as well. For RPA to achieve higher rate of partial automation, the invoice quality should increase. Quality would be higher standardisation and more relevant information in an invoice. As paper invoices tend to have less information per both interviewees and Lahti & Salminen (2014, 64), their number should be further dropped. Indeed, Lahti & Salminen (2014, 77) mention that an organisation should demand its vendors to send only e-invoices. However, getting rid of paper invoices completely is currently almost impossible because some foreign countries require paper invoice to return VAT (Lahti & Salminen 2014, 64). Vantaa, too, had some international acquisitions (HRI 2017;2018). Vantaa could estimate how much more receiving paper invoices from individual vendors cost compared to receiving e-invoices. If this cost is high, it should be notified when sellers are tendered. For example, if the best offer costs x euros less than the second best but the second uses e-invoices whereas first does not and the savings from using e-invoices is higher than x, the second offer is actually cheaper.

Lahti & Salminen (2014, 58) also suggest that companies should prefer ERPs' invoicing modules to independent invoicing software as this reduces need for connection updating. This is not the case in Vantaa city for the time being. Other practices Lahti & Salminen (2014, 58-59) emphasise are that principles, processes and guidelines should be applied organisation-wide and that organisation should be optimised by concentrating or outsourcing processes. These practices are already applied in Vantaa since guidelines are provided to departments and accounts receivable, accounts payable and other activities are highly concentrated on respective teams in financial shared services centre.

"Alternatives of RPA" subchapter presents several automation solutions that do not require RPA. Lacity et al. (2016, 24-29; 2015a, 8) mention in their article a few methods to reduce cost without RPA: IT departments changes to business logic and data access layer of systems and programs, abandonment of tasks with little actual value and outsourcing processes. The IT department-related solution could be summed up as "heavyweight IT" which has been mentioned by (Lacity et al. 2016, 24,27-28), Slaby & Fersht (2012, 5), Asatiani & Penttinen (2016, 68) and Forrester research (2014, 3-4). Furthermore, Aloini et al. (2012, 484) argued that at least ERP software implementation and changes can be challenging from IT's perspective among others. Among these RPA researchers seems to be a consensus that RPA is not necessarily a direct alternative to heavy IT, but they can complement each other. Indeed, purchase invoice team already benefits from such computing as invoice software is programmed to perform many tasks in accounts payable process, e.g. archiving with a single press of an icon and commonly routing the invoices with enough relevant information. It is also connected to ERP. However, if invoice software is possible to integrate with information from online Excels and in other respects execute similar commands the robots can, Vantaa could calculate whether it is more affordable to include online Excels' data into invoice software's database or have the robot do this. However, the literature suggested in all cases where the price of the BPM solution and RPA solution were compared that RPA was less expensive (Slaby & Fersht 2012, 10; Lacity et al. 2016, 28). RPA could outperform outsourcing too as in Lacity et al.'s (2016) Telefonica O2 case.

Lacity et al. (2016, 26) mentioned that at least O2 Telefonica company was able to reduce its back-office costs by stopping manual verification of order shipments. When call-off decision was made, the error rate was 0,01%. In Vantaa booking-related and other errors seem to be above this, so potential errors can well be costlier than in case of O2. Moreover, the two back-office tasks are not identical. Lacity et al. (2016) mentioned in their article outsourcing as well. Outsourcing's relation to RPA has been discussed by Slaby & Fersht (2012) and Asatiani & Penttinen (2016) too. Table 5 already presented the robot's cost compared to offshore outsourced FTE and onshore worker. The literature suggests that offshore workers are cheaper than domestic ones. However, there are tasks that are hard to outsource as Lacity et al. (2016, 26) mentioned. For Vantaa, extra difficulty adds that most invoices are domestic and in Finnish or Swedish (HRI 2017;2018). Languages that are seldomly spoken abroad. As mentioned in the interview, receiving and scanning e-invoices is outsourced. This outsourcing could potentially be sent offshore but that would take it longer for Vantaa to receive these invoices into their own invoicing software as the paper invoices would have to be send abroad for opening and scanning. Even though literature had no indication of it, in the interview it was approximated that in a fast-changing environment a human likely outperforms robots and BPM solutions; human is expected to learn exceptions and new situations faster than a robot or faster than they are programmed to deeper layers of software systems. Moreover, these changes can be taught to human without any programming skills.

5.4.3. Future prospects: implementation to new processes

Robots capabilities to type data instead of merely checking it would lead to higher level of automation and this should be investigated in the future. Based on interview, online Excels appear as a practical solution for repeating contracts. Vantaa could expand its use of online Excels with those vendors whose invoices are long, i.e. have lots of rows, but also have repeating characteristics. The city could choose these vendors e.g. by invoice volume and total spending. Of course, these invoices need to have suitable identification codes for individualisation so that same ID code always demands same account, VAT code and cost centre. Then robot would not have to read as much information from XML but could use more standardized Excels instead.

In the interview, there were talks that robots could one day send due date notifications for approvers via email. This possibility was also discussed by Helsinki (2017a). Robots could also start upgrading or even creating vendor information and maybe search from database whether same enterprise identification number, "y-tunnus", is applied with two or more vendor names and then connect them to become only one vendor. Yet another extension could be that robots start to check or even type correction memos into accounting as the memos should always follow the same city-wide standard. Furthermore, given robots' capabilities with "swivel chair processes", they could be extended to create monthly, or other repetitive, reports: a robot could get the right report with right information level from ERP, e.g. certain department's cumulative acquisition expenses, and then save it and send it to right persons as an email attachment. Indeed, the robots could handle hierarchical data as Penttinen et al. (2018, 7) exhibited. This operation does not take long from reporting specialists but would nevertheless save some of their time. There are also some time-consuming reports that have to be made periodically based on legislation. As these reports always follow same pattern, they fall under this idea too.

Interviewees noted that HRM could start using robotics in several tasks. Especially in ones where people's personal matters are handled. Indeed, this expansion is already piloted. This HRM expansion has already been executed in the government as Palkeet (2018) has robots fill absence information. Interviewee 1 mentioned that robots would fit perfectly for handling delicate personal information. Another IT and possibly HR-related task that could benefit from the robotics is giving user rights. Robots can work faster than a human and is not limited by 8-hour workday, so it could potentially perform some subprocesses of user right process, given that the subprocesses are not entirely outsourced. Robotics expert could also be notified on costs before decision to do these process implementations.

Another solution that would help both robots and invoice circulation software is demanding vendors to use more information and more standardized information in invoices they send. Indeed, Lahti & Salminen (2014, 68) emphasised too that the information required to autocomplete invoices should be demanded from vendors. Moffitt et al. (2018, 5) also recommended requiring standardized information from stake holders.

5.5. Reliability and validity of the case study

According to Vanhala (2016, 5-6), reliability means function's ability to not only execute but also maintain itself in all circumstances. A reliable research should be trustworthy and consistent. Vanhala further argues that reliability fits better into quantitative research, but qualitative research can nevertheless be measured with "*documentation of how data was collected and analyzed*" and graphs and figures depicting raw data. (Vanhala 2016, 5-6). Data collection included two methods: interviews for empirical part and previous literature for theoretical part. The interviewees would likely give the same answers to these questions in later years if the interviews would again handle the project at this stage, i.e. situation after one year. This would occur because the interviews handled matters that have already occurred and changing answers to them would mean that Vantaa had at current state misunderstandings regarding information needed to answer these questions. Some of the current challenges may be solved later and therefore the interviewees could in the future mention that at this stage solution to some matter was not yet known. Moreover, after another year or so Vantaa's RPA model, price per task, processes where robots are used etc. may have changed, but this does not reduce reliability of the state after one year. There were only two interviewees so only two opinions were received but these were the opinions of the RPA coordinator focusing more on RPA than anyone else in the team and superior of the accounts payable team with most knowledge of the accounts payable process. Quantitative methods would have required several examples as it is based on statistic methods requiring several examples, and variables, and therefore couldn't have been used properly.

The appropriateness of referenced literature was already discussed in chapter "Methodology" and in the beginning of chapters 2-4. There it was mentioned that most sources are peer reviewed and some that are not are at least written by researchers with other peer reviewed articles. Most others are at least included in Finna database. The literature included a lot of articles from the same writers so not a huge amount of different writers' opinions was received. Nevertheless, different writers, commonly cited or not, had rather mutual opinions on RPA and often referred each other's studies.

Vanhala (2016, 5-6) has defined validity as method to ensure that *"research really measures what it is supposed to measure".* While reliability tells whether the measuring methods are correct, validity focuses that the measurement units really measure the asked question. Validity answers questions: is the research accurate and is the research credible. This can be answered e.g. with triangulation, thorough reporting of data collection and results and letting interviewees inspect them. (Vanhala 2016, 5-6). Because a valid study should measure what it is supposed to measure, the results of the thesis should answer precisely the chosen research questions and not some other questions and both theory and empirical parts should help to produce these results. Data collection is presented in the introduction whereas research question and answered in more detail in the next chapter. The interviewees have also checked that the empirical part cites them accurately in January 2019.

6. Discussion & Conclusion

This chapter presents conclusions that also work as summary for the research questions. The latter subchapters present limitations and critique for this thesis and finally recommendations/ideas for further research.

6.1. Conclusion

Both research questions and their sub-questions are handled in this chapter. Sub-questions 1a and 2a, as well as 1b & 2b and 1c & 2c differ mainly in perspective: research question 1 derives from literature's findings whereas research question 2 covers the same matters but from case's perspective. Research questions are presented in the following order: first sub-questions in alphabetical order and then their main question which will also work as a sum up for the whole research question and its sub-questions.

The first research question was "How and when RPA is a suitable method to improve financial administration's processes". Conclusions for the question and its sub-questions are presented below.

"Examples of RPA" chapter included previous situations where financial processes have been automated with software robots. KPMG (2017) uses as an example of robotic automation opening an invoice sent as an e-mail attachment and then copying its information into system of record. Slaby & Fersht (2012, 5) mention creation of credentials and maintaining general ledger. Keuper (2017) lists transactions in trade finance, cash, loan and tax operations suitable for robotic process automation. Helsinki (2017, 123; 2017a) utilises RPA in sending remainders to invoice approvers and drawing memos. Palkeet (2018; 2018a) has more extensive use than Helsinki since they have broadened RPA into purchase e-invoice's number checking, updating vendor register, routing accounts payable documents and reconciliating accounting transactions. Lacity et al. (2015a; 19) mention mortgage lending assessment and ID searches. Moffitt et al. (2018, 4-6) add auditing tasks like revenue testing and compilation of audit test results. Previous LUT thesis made by Lintukangas (2017, 68) examined vendor creation, invoice approval reminders, reconciliation of accounts and data checking's suitability for RPA.

Best method would require that RPA is more effective than other methods to execute the same task. Literature made no reference that other methods were better than RPA in cases were RPA was used. Especially Lacity et al. (2016) and Penttinen et al. (2018) had examined cases were RPA was thoroughly compared with other solutions, manual labour and BPM, and found to outperform them in respective occasions.

The example tasks had following characteristics: rule-base, high volume/price/human error rate, low complexity, stable software, information in machine readable script and or involvement of several software tasks (Asatiani & Penttinen 2016, 68-69; Zarkadakis et al. 2016; Lacity et al. 2015b, 9; Slaby & Fersht 2012, 6-7). These characteristics can apply to many business processes, including financial administration. One could argue that these characteristics for a potentially automated task are the most important success factors. Literature has, however, discussed more thoroughly what factors make the whole RPA project successful. They include more than just what kind of properties make a task suitable for effective automation but also discuss organisational characteristics. These factors were listed for tasks and organisation separately in table 8. Not all writers suggested same procedures but there were no cases present where writers recommended exactly opposite procedures. Furthermore, organisational recommendations are only listed by Lacity, Willcocks & Craig so no other writers' opinions are present.

Table 10 listed RPA cases from literature and their profits. Writers have not mentioned that any of the cases were unprofitable and highest profits were found to generate 800% three-year ROI. This profit tends to come from labour cost savings (Helsinki 2017a; Lacity et al. 2016). Others have been able to locate labour force into more productive tasks (Lacity et al. 2015b, 5; 2016, 28; Helsinki 2017a). RPA is relatively profitable only if it brings higher payoff than its alternatives. The highest ROI mentioned earlier was achieved by partly replacing offshore outsourcing (Lacity et al. 2016). Slaby & Fersht (2012), Asatiani & Penttinen (2016; 2018) and Lacity et al. (2016) have all mentioned heavy IT, i.e. programming, as an alternative to RPA. Per literature, (Lacity et al. 2016, 28; Slaby & Fersht 2012, 10-12; Penttinen et al. 2018), RPA can outperform, at least monetarily, BPM solutions when it is automating processes with data transfer between several systems. Such multiple system-involving task is present in Vantaa when robot checks data from online Excel and then copies it into ledger software. Penttinen et al. (2018) found also a case where

RPA outperformed back-end automation in search task that involved only one system although they concluded that generally BPM is better solution when there is only one system involved.

When financial administration is not organisation’s core business but is limited to a support role, reduce in its costs shouldn’t reduce primary activities quality. Table 10 listed returns RPA has generated per literature. As far as financial processes are concerned, Palkeet (2018; 2018a) has seen 20% increase in efficiency but this is achieved with other solutions in addition to RPA whereas Helsinki (2017) has no precise estimation but mentions that one task saves few working days. If Xchanging company’s processes, which are back-office processes for insurance, are counted then RPA has achieved return of 11-30% per process (Lacity et al. 2015a, 18). Table 10 presented higher return for some other processes in other business fields which could mean that financial administration is possibly not the most lucrative target for RPA but nevertheless can well be profitable. As mentioned earlier, the amount of cases was very low, and both literature and interviews emphasised that features of process like low complexity (see table 8; Del Rowe 2017; Moffitt among others) matter more than being financial administration’s process or not. Vantaa’s case is likely closest to that of Helsinki, Palkeet or Espoo as they are all large public organisations just like Vantaa is and have all automated financial processes. Indeed, a further research suggestion is comparing these organisations’ profitability and other relevant variables.

Research question “How and when RPA is a suitable method to improve financial administration’s processes” is now summed up with its sub-questions. As mentioned in introduction chapter, “when” refers to circumstances under which robotics can prosper. Per table 8 and other sources, RPA is most suitable for processes and tasks which have little exceptions, volume/price is high and, most importantly, can be defined with rules. Transferring and checking invoice data, creating invoices, opening and modifying vendor information and reconciliating accounts are example tasks that have been handed over to software robots. Then again, Asatiani & Penttinen (2016) and Lacity et al. (2016) argue that at very high volumes RPA is not the most optimal solution at least if only one software is involved in the task. This could indicate that the most high-volume tasks are better to automate with BPM solutions. In financial administration this would be different tasks related to invoices, like sales invoice creation, booking and routing purchase invoices, creating pay checks and archiving all the above. Many of these tasks were listed to be suitable for RPA too, so defining at which point each solution is best can be difficult. Both interviews and literature (Lahti &

Salminen 2014; Penttinen 2008) considered that purchase order invoices were an example of item that can fully be automated even without RPA. As this invoice type is very standardized, it seems that very well standardized items have also less need for RPA. At the other end, least rule-based invoices are best handled by a human.

The research question had also a “how” part. This refers to means by which RPA becomes practical. Automating only tasks that have characteristic mentioned at the beginning of the previous paragraph would be a mean to ensure that robots have high possibility to succeed. There are other matters that could be considered too: like following success factors in organisational level. A suitable organisation can utilise RPA in more strategic way as Lacity et al. (2015a; 2015b) found out. Understanding processes is also important: there needs to be people who know what subprocesses there are and is RPA suitable for any of them (Lacity et al. 2015a, 30-33). Robots don’t need to be applied to all subprocesses, but just to most suitable ones.

The second research question was “Has Vantaa been able to utilise robotics in a way literature suggests”. This question, as well as its sub-questions, are answered below.

Lintukangas, Helsinki and Palkeet’s examples were closets to the tasks executed in Vantaa where robots perform among others VAT checking, routing and, for invoices with certain ID code, booking, as mentioned in chapter “Situation after RPA implementation”. Per figure 7, robots in Vantaa conducted four tasks, some of them with several phases like checking cost centre, month and account. Vantaa has utilised robotics in somewhat less processes than Palkeet (2018; 2108a) or Lacity et al.’s (2016;2015a) case companies O2 and Xchanging (see table 10). This is because Vantaa has only passed pilot stage and has plans to implement RPA into new tasks like sending remainders and even to processes in HRM. (interview; interview2). Lacity et al.’s (2015b, 10) case company had slow implementation too making Vantaa not the only one to implement RPA slowly. Nevertheless, other examples indicate that Vantaa has had slower implementation than many others (Penttinen et al. 2018, 4; Lacity et al.2016, 27-28).

As discussed in the beginning of chapter “Results and analysis of the case”, financial shared services centre utilises RPA in high-volume, rule-based tasks and may need multiple systems to accomplish them. The literature emphasised that the tasks need to follow standards and have little exceptions. Invoices Vantaa receives have different kinds of information and forms making the invoices hard for robots to read. Thus, they are unstandardized. Vantaa acknowledges this challenge as interview 1 presented. Like literature recommended, Vantaa has monitored the cost structure of the automated tasks. Head of accounts payable team knew these costs, but head of RPA didn't - yet. This differed from Lacity et al.'s (2015b) idea that head of RPA should be briefed on all RPA matters. However, robotic expert's duty is not to count costs but to decide what tasks are automated. Per robotics expert, the error rate has decreased as robots make no mistakes unless accidentally programmed to do so. Vantaa is rather close to Lacity et al.'s (2015a;2015b) organisation recommendations. Besides the interviewed robotics expert, a board of other employees exists and partakes in implementation, challenge management, task expansion and monitoring-related matters. Roles of humans and robots are distinct; thus, cooperation is clear. Vantaa has also strategy for RPA expansion and there are plans into which processes robotics is applied next. Robots were taught several, if not all, programmed tasks too. Some organisational differences compared to literature exist: standardisation of process and consistent delivery type. As far as standardisation refers to same kinds of invoices and other documents from providers, Vantaa is not the only one with this problem (Lintukangas 2017, 64). Standardisation is not up to Vantaa alone: different providers use their own kinds of invoices and may be reluctant to change their type. The RPA delivery type may change as Vantaa's doctrine requires tendering out external providers and possible new provider may have new delivery type. Maintenance requirements were not discussed but these are likeliest to arise, if Vantaa's software change or documents start to follow a new format which requires re-configuring robots.

Assessing profitability of Vantaa's project couldn't be executed precisely. The interviewee 1 considered that the project is profitable. Indeed, interview emphasised that RPA makes no mistakes. unless by accident programmed to do so, and generally works faster than human. Therefore, it saves employees time and reduces risk of mistakes. Furthermore, it was not the idea that financial shared services implemented RPA for solely monetary reasons. Indeed, there is also an example from literature where RPA implementation's drivers were more than just profit but also "*multiple operational benefits and strategic payoffs*" as Lacity et al. (2015b, 5) summarise. Moreover, without RPA Vantaa may have had to employ new people because the number of invoices is on the rise and Vantaa has centred substantial share of all financial services into shared services (Helsinki Region Infoshare 2017a; 2018; Vantaan kaupunki 2017; 72-73). Therefore, a break-even analysis could be calculated with the salary of a new employee/employees compared to costs of robots. Robot and employee time could be changed into minutes as Lacity et al. (2016, 31) cite. Payback period can then be calculated by dividing implementation costs with robots' profit margin.

In addition to absolute profitability, relative one should also be discussed. This could have been some sort of heavyweight IT and scrutinising this opportunity could provide an opportunity for further research. However, as Asatiani & Penttinen (2016) and Lacity et al. (2016) already emphasised, RPA is a solution of its own kind and not necessarily a replacement. Moreover, it is uncertain whether such programming would be efficient since the biggest problem seems to be quality of invoices. Vantaa's primary alternative for RPA would have been continuing the use of manual labour; which was considered by the interviewees as less effective solution. As mentioned, the robots were considered faster and more precise than humans. Moreover, handling certain order invoices was less complex for robot than for human: the robot immediately recognises these invoices and checks to which cost centres and accounts it should be booked into based on Excel sheets whereas it would take much longer for a human to check these data. Another alternative for RPA, but also a method to enhance the RPA, is requiring higher quality e-invoices from vendors. This would make it easier for ledger software to handle the invoices too. Higher quality meant presence of relevant information in a computer readable form: above all XML script.

Research question "Has Vantaa been able to utilise robotics in a way literature suggests" is summed up in next three paragraphs. Just like case companies in literature, Vantaa's core business is not financial administration and its role is therefore supportive. Indeed, welfare and educational matters are city's primary functions. Unlike companies scrutinised by Lacity et al. (2015a;2015b;2016), Penttinen et al. (2018) and Hodson (2015), Vantaa's financial shared services centre was not private but public. Shared services centre was not very international either, unlike Lacity et al. and Lintukangas' (2017) case companies. However, Vantaa's shared services had RPA organisation that was quite similar to Lacity et al.'s (2015a;2016) suggestions. Lacity et al. (2015a, 30-31) also recommended that the project has a distinct head of RPA who concentrates entirely on robotics and knows all about the project. This was not yet entirely the situation as robotics expert was currently not informed about financial issues. This was going to change, however. Many organisations were faster to implement robots into their processes, some requiring as little as 1-3 months compared to Vantaa's over six months (Lacity et al. 2016, 28; Penttinen et al. 2018, 4).

One should notice that Vantaa had in many respects effective financial administration to begin with. 87% of purchase invoices were e-invoices and many others were scanned with optical scanner. Sales invoice handling efficiency had had significant increase too. Vantaa's purchase invoice process was quite alike with that of Penttinen (2008, 15) and Lahti & Salminen (2014, 57) too. Moreover, Vantaa utilises purchase order invoices and other types of e-invoices which Lahti & Salminen (2014, 67-69) found effective solutions. Vantaa has also concentrated services just like Lacity et al. (2015a, 3) recommended. One should also remember that potential citywide savings of RPA are limited: financial administration forms less than percent of all expenses (Vantaa BI 2018b). The process Vantaa automates, purchase invoicing, is mentioned by several writers (Slaby & Fersht 2012; Moffitt et al. 2018; Lacity et al. 2016, 27) as a good fit for RPA. Moreover, the subprocesses this process includes have many properties that are considered suitable for automation (Asatiani & Penttinen 2018; Slaby & Fersht 2012; Lacity et al. 2015b). Indeed, also Palkeet and Helsinki have utilised RPA in tasks that are like ones in Vantaa. Literature emphasises that transferring information from one system to another is a strength of RPA (Lacity et al. 2015;2015a;2015b;2016; Asatiani & Penttinen 2016). Vantaa could try to expand its use of robots in such tasks by creating more online Excels where the robots can check information and fill it into ledger software. Indeed, this practise is advancing in Vantaa although such Excels require constant updating. (interview 1; interview 2).

Robotics has reduced demand for human labour in the tasks it has been implemented into and these labourers can now focus on more complex tasks, like answering questions from stakeholders, just like Lacity et al. (2016) and Digital Workforce (2018) mentioned. Robots need constant monitoring, though. Per interviewees, RPA has been profitable. Profitability calculation was not provided since project was ongoing so comparison to literature is not possible in this field. Vantaa could gather all costs and profits from their project and calculate current ROI. When interviewees verified that they were cited accurately, it was learned that Vantaa had planned to execute suggestions to increase online Excels, expand to HRM and notify RPA expert on finances from chapter "Implementation to new processes", which were, in turn, made based on literature. For new tasks RPA is considered to be implemented into, break-even analysis could be conducted. One should remember, though, that Vantaa did not execute the project only for profits but also to save employees time for other tasks, an approach that was found in literature too (Lacity et al. 2015b, 5). Indeed, it can be said that public organisation didn't have different approach to RPA as it had similar process requirements for robots, rather similar organisation and similar goals.

6.2. Critique and limitations

The interview was done with robotics expert and head of accounts payable team only. Some of the case-related monetary interview questions couldn't be fully covered with answers from the interviews. As these questions couldn't be answered utilising other sources either, answer to research question 2C remains unprecise. This applies especially to monetary values such as precise costs of robotics and current manual cost of entire processes. Vantaa does have knowledge of these numbers, but they were too delicate to publish in this research.

The second interview partly verified the findings from the first which should add reliability to this thesis' empirical findings. In addition to having only two interviews, there was only one case present and its empirical findings were limited to accounts payable process in public organisation. Therefore, wider spectrum of financial administration processes, listed by Lahti & Salminen or Asatiani, were covered with available literature sources and briefly, in broad level, in interviews and materiel Vantaa has created. No researches focusing on RPA in purchase invoicing was available for precise comparison even though Lintukangas' (2017) thesis did cover RPA in indirect procurement and Palkeet (2018;2018a) had brief announcements of financial administration processes and tasks they have automated. This thesis was also not able to follow the entire RPA implementation process as the project was not yet wholly complete - given that automation project can ever be entirely complete as changes in invoices or systems may always lead to reconfiguration of the robots. As there are so few literature sources about financial administration's automation with software robots and none focusing on purchase invoicing, this thesis can potentially add knowledge to that field.

The findings of this thesis supported the findings made by previous literature in several respects: RPA can be successfully implemented into tasks that are rule-based, repetitive and have high volume. In fact, Vantaa's robotics expert even estimated that small volumes suffice if task follows rules, repeats daily and is critical. Moreover, as mentioned in previous paragraph, no previous research was devoted to RPA in public organisation and very few had detailed research on RPA in accounts payable process.

6.3. Avenues for further research

In some cases, researchers have been able to calculate ROI and payback period (Lacity et al. 2015a; 2016) for some organisations. It would be a sound extension to this research to calculate precise profitability of Vantaa's RPA project. Obviously, further research could include mapping into which tasks Vantaa could implement RPA next. This was already suggested in subchapter "Future prospects: implementation to new processes".

In addition to mentioning that RPA fits well into low complexity – high volume tasks, the literature has currently some examples of mapping success factors of RPA. Lacity et al. (2015a), Slaby & Fersht (2012) and Asatiani & Penttinen (2016) being among them. A comparison between their success factors and the factors found by new researches could be made. Another comparison that could be scrutinised in the future is between Vantaa's RPA project and Palkeet, Helsinki or Espoo's respective project. This could provide insight, which public organisations has been most successful in implementation of different tasks and others could then utilise this sort of implementation and usage. All RPA examples are from larger companies. Further research could try to identify whether RPA has potential for SMEs or has there already been cases of SMEs utilising RPA.

As shortly discussed in "Introduction" chapter, a quantitative hypothesis could have been "robot is more cost-effective than the previous (more labour-intensive) solution" or "RPA is easier, faster and/or more affordable than other automation solutions". These questions would have required higher sample size than was present in current literature. In the future, however, there may be enough case studies of RPA implementations into different organisations and tasks and sufficient number of variables to conduct a quantitative study. Variables could include implementation time, payback period and other variables listed in table 10. Emphasis could also be put into non-monetary variables like personnel satisfaction.

RPA could also be even further compared to other solutions. Especially in which cases outsourcing and API changes are more affordable. The current literature mentions a few occasions where companies chose RPA over heavy weight IT (Lacity et al. 2015a;2015b;2016; Penttinen et al. 2018) and researchers could use saturation to find out whether these cases are generalizable. Furthermore, Penttinen et al. (2018, 11-12) have created a methodology to compare the two solutions and it could be used by e.g. Vantaa for considering whether a new process should be automated with either of the solutions. Vantaa has focused RPA on checking data and less on creating it. A further research could try to find examples in accounts payable process where the robots can copy-paste or type data more intensively.

Further qualitative research could focus more on artificial intelligence and machine learning's potential as a developer of RPA. As mentioned in the introduction, Del Rowe (2017) cites an earlier finding by Frost and Sullivan that RPA uses software incorporating AI, ML and other technologies to automate routine tasks. Both Boulton (2017) and Moffitt et al. (2018, 9) suggest that AI and machine learning will be more incorporated with RPA in the future. Zarkadakis et al. (2016) too have risen question about incorporation of cognitive automation and RPA; are they utilised together or is RPA going to be replaced. Palkeet (2018a) has already announced their incorporation of AI and RPA. The principals of machine learning were shortly presented in chapter "Financial Administration's Automation Solutions in Current Literature". Machine learning extension could be that robot constantly observes how human corrects or accounts an invoice and then, based on e.g. certain variables, starts to correct new invoices with the learned information. This requires that invoices have certain patterns for machine to learn and recognise. Indeed, machine learning has several types of algorithms: supervised learning, unsupervised learning, reinforced learning, similarity learning and association rules (Mezei 2016, 25). Similarity learning could potentially benefit RPA: based on large data and available information, utility matrix may deduct missing values as Mezei (2016, 59) points out in his example handling film preference matrix. Such method could maybe be used in invoices in at least following case: sender name, reference number and product name are present, but the invoice lacks the sender company's name. Based on previous data, the robot could then fill the company name as it can be deducted from the rest of the information. Of course, considering that errors can be costly, it may be too risky to let the robot/software write down information that is not actually correct. Machine learning can be an alternative to creating rules manually. The software inspects how human works and after several cases learns to do the same things. An important question could be whether there are enough patterns for such implementation to be profitable.

References

Abzaltynova, Z., Williams, J. (2013). Developments in business intelligence software. Journal of Intelligence Studies in Business. Vol.3(2), pp.40-54. [online]. Available at: https://wilma.finna.fi/lut/PrimoRecord/pci.scopus2-s2.0-84905679994 [Accessed 26 June 2018]

Aloini, D., Dulmin, R., Mininno, V. (2012). Modelling and assessing ERP project risks: A Petri Net approach. European Journal of Operational Research. Vol.220(2), pp.484-495. [online]. Available at: https://ac-els-cdn-com.ezproxy.cc.lut.fi/S0377221712001002/1-s2.0-S0377221712001002-main.pdf?_tid=93be52b0-bbfe-4f86-b794-cee059ffda56&acdnat=1531385016_496fbf1c578e3d095edd7c3b00ed8a85 [Accessed 12 July 2018]

Asatiani, A. (2016). Impact of Cloud Computing on Business Process Outsourcing - Case: Accounting in Small and Medium-sized Enterprises. Dissertation. Aalto University. [online]. Available at: https://aaltodoc.aalto.fi/bitstream/handle/123456789/22983/isbn9789526069463.pdf?sequence=1&isAllowed=y [Accessed 3 May 2018]

Asatiani, A., Penttinen, E. (2016). Journal of Information Technology Teaching Cases. Vol. 6(2), pp.67-74. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/1872245273 [Accessed 3 May 2018]

Atrill, P. & McLaney E. (2006). Accounting and Finance for Non-specialists. 5th edition. Prentice Hall.

Automation anywhere. (2018). IQ BOT - Cognitive automation change maker. Impact in under 8 weeks. [online]. Available at: https://www.automationanywhere.com/products/iq-bot [Accessed 28 May 2018]

Avain 2018. (2018). Talouspalvelukeskus. Vantaa’s Intranet. [online]. [Accessed 8 June 2018]

Avain 2018a. (2018). Talousyksikkö. Vantaa’s Intranet. [online]. [Accessed 8 June 2018]

Barlow, D., Barge, C. (2001). E-invoicing. International Tax Review, suppl. E-Commerce. Iss. 4 (2001), pp. 76-83. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/230207572/?pq-origsite=primo [Accessed 20 June 2018]

Basu, P; Nair, S K. (2012). Analysis of back-office outsourcing contracts for financial services operations. The Journal of the Operational Research Society. Vol. 63 (12). [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/1133634197/fulltextPDF/1036EA72C3C4584PQ/1?accountid=27292 [Accessed: 11 July 2018]

Boulton, C. (2017). What is RPA? A revolution in business process automation. Computerworld Hong Kong. [online]. Available at: https://wilma.finna.fi/lut/PrimoRecord/pci.proquest1967207793 [Accessed 26 Apr. 2018]

CGI 2016. (2016). CGI kehitti robotiikkapalvelun kuntien taloushallinnon tehostamiseen. [online]. Available at [Finnish]: https://www.cgi.fi/uutiset/cgi-kehitti-robotiikkapalvelun-kuntien-taloushallinnon-tehostamiseen [Accessed 26 June 2018]

CGI 2018. (2018). Virtaviivaista prosessisi ja hallitse dokumenttiesi koko elinkaari. [online]. Available at [Finnish]: https://www.cgi.fi/tuoteratkaisut/rondo [Accessed 26 June 2018]

Chaudhuri, S., Dayal, U., Narasayya, V. (2011). Communications of the ACM. Vol.54(8), pp. 88-98. [online]. Available at: http://delivery.acm.org.ezproxy.cc.lut.fi/10.1145/1980000/1978542/communications201108-dl.pdf?ip=157.24.2.22&id=1978542&acc=ACTIVE%20SERVICE&key=74A0E95D84AAE420%2ED6ACE573DB6EB0FF%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1530033627_f0df7cf708ba0b2646474af441d1f922 [Accessed 26 June 2018]

Chui, M., Manyika, J. and Miremadi, M. (2015). Four fundamentals of workplace automation. McKinsey Quarterly, November. [online]. Available at: http://www.mckinsey.com/business-functions/business-technology/our-insights/fourfundamentals-of-workplace-automation [Accessed 4 July 2018]

Collan, M. (2016). Information Systems in Corporate Management and Decision-making. LUT lecture. [Accessed 24 Mar. 2018]

Davenport, T., Kirby, J. (2016). Just How Smart Are Smart Machines?. MIT Sloan Management Review. Vol. 57 (3), pp. 21-25. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/1778414393/550B8D59C3844A69PQ/2?accountid=27292 [Accessed 3 Oct. 2018]

Del Rowe, S. (2017). RPA Has Its Upsides. Customer Relationship Management. Vol.21(12), pp.13. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/1973927156?pq-origsite=primo [Accessed 24 Feb. 2018]

Digital Workforce, (2018). Digityöntekijä. [online]. Available at [Finnish]: https://digitalworkforce.fi/digityontekija/ [Accessed 8 Jan. 2018]

Ertel, W. (2011). Introduction to Artificial Intelligence. 2nd edition. Springer.

European Union. (2018). Financial Reporting. [online]. Available at: https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/financial-reporting_en [Accessed 4 Mar. 2018]

Espoo 2018. (2018). Talousarvio 2018. [online]. Available at [Finnish]: https://www.espoo.fi/fi-FI/Espoon_kaupunki/Paatoksenteko/Talous/Talousarvio [Accessed 4 July 2018]

Erto. (2016). Taloushallintoalan palkankorotukset 1.1.2018 alkaen. [online]. Available at [Finnish]: https://www.erto.fi/tietoa-ertosta/tiedotteet/mediatiedotteet/2953-taloushallintoalan-palkankorotukset-1-1-2018-alkaen [Accessed 21 June 2018]

Excel Forum. (31.1.2006). Control items outside of excel. [online]. Available at: https://www.excelforum.com/excel-programming-vba-macros/506967-control-items-outside-of-excel.html [Accessed 28 May 2018]

Forrester Research. (2014). Building A Center of Expertise to Support Robotic Automation. Forrester Consulting. [online]. Available at: http://neoops.com/wp-content/uploads/2014/03/Forrester-RA-COE.pdf [Accessed 4 July 2018]

Garberg, M. (2017). Mulighetsstudie på Robotic Process Automation (RPA) i industriell lagervirksomhet. Master thesis. Universitet i Stavanger. Available at [Norwegian]: https://brage.bibsys.no/xmlui/bitstream/handle/11250/2456219/Garberg_Marcus.pdf?sequence=2&isAllowed=y [Accessed 3 Mar. 2018]

Granlund, M. & Malmi, T. (2004). Tietotekniikan mahdollisuudet taloushallinnon kehittämisessä. 1st edition. WSOY.

Helsinki 2017. (10.10.2017). Helsingin kaupungin talousarvio 2018. [online]. Available at [Finnish]: https://www.hel.fi/static/kanslia/Julkaisut/2017/HKI_TA_2018_web.pdf [Accessed 3 July 2018]

Helsinki 2017a. (1.12.2017). Robotti ryhdisti laskujen käsittelyä. [online]. Available at [Finnish]: https://www.hel.fi/uutiset/fi/taloushallintopalvelu/robotti-ryhdisti-laskujen+kasittelya [Accessed 3 July 2018]

Hernandez-Ortega B. (2012). Key factors for the adoption and subsequent use of e-invoicing. Academia, Revista Latinoamericana de Administración. Iss 50, pp. 15-30. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/1271600028?accountid=27292 [Accessed 20 June. 2018]

Hodson, H. (31.3.2015). AI interns: Software already taking jobs from humans. New Scientist, [online]. Available at: https://www.newscientist.com/article/mg22630151.700-ai-interns-software-already-taking-jobs-from-humans/#.VY2CxPlViko [Accessed 17 Jan. 2018]

HRI 2017. Vantaan kaupungin ostot - Ostolaskut 2015. [online]. Available at [Finnish]: https://hri.fi/data/dataset/vantaan-kaupungin-ostot/resource/7cb61314-c121-41dc-9cb1-73b0c87d5130?inner_span=True [Accessed 23 Aug. 2018]

HRI 2017a. Vantaan kaupungin ostot - Ostolaskut 2016. [online]. Available at [Finnish]: https://hri.fi/data/dataset/vantaan-kaupungin-ostot/resource/319aa121-c97c-41b9-9b6d-30344c6dc7f3?inner_span=True [Accessed 23 Aug. 2018]

HRI 2018. Vantaan kaupungin ostot - Ostolaskut 2017. [online]. Available at [Finnish]: https://hri.fi/data/dataset/vantaan-kaupungin-ostot/resource/27782b97-2089-4089-a113-fa20086a3c9e?inner_span=True [Accessed 23 Aug. 2018]

Hutter, M. & Legg, S. (2007). Universal Intelligence: A Definition of Machine Intelligence. Minds and Machines Vol. 17(4), pp. 391-444. [online]. Available at: https://link-springer-com.ezproxy.cc.lut.fi/content/pdf/10.1007%2Fs11023-007-9079-x.pdf [Accessed 28 May 2018]

Kankaanpää, R. (2018). Interview. [2.10.2018]

Kaplan, C. (2011). Transforming the back-office a single keystroke. Healthcare Financial Management. Vol.65(9), pp. 118-124. [online]. Available at: https://wilma.finna.fi/lut/PrimoRecord/pci.proquest892465159 [Accessed 16 Aug. 2018]

Keuper, R. (2017). Robotic Process Automation (RPA) im Banking. Bankstil. [online]. Available at [German]: https://bankstil.de/robotic-process-automation-rpa-im-banking [Accessed 16 Apr. 2018]

Kim, J-I. & Shunk, D.L. (2004). Matching indirect procurement process with differentB2B e-procurement systems. Computers in Industry. 53(2), pp. 153-164. [online]. Available at: https://www-sciencedirect-com.ezproxy.cc.lut.fi/science/article/pii/S0166361503001830?via%3Dihub [Accessed 3 Mar. 2018]

KPMG Nederland. (23.10.2017). Robotic Process Automation (RPA): how does it work? [online]. Available at: https://www.youtube.com/watch?v=xW95yb6J1eU [Accessed 19 Mar. 2018]

Kuntatyöntekijät. (2017). Kuntasektorin kuukausipalkat ammateittain vuonna 2016. [online]. Available at [Finnish]: https://www.kvtes.fi/index.php?option=com_content&view=article&id=31&Itemid=226 [Accessed 9 June 2018]

KVTES. (2017). KVTES. [online]. Available at [Finnish]: https://www.kt.fi/sopimukset/ukk/kvtes/tuntipalkka [Accessed 9 June 2018]

Laamanen, H. (2005). Xml-verkkotietokantojen suorituskykyvertailu. Master’s Thesis. Lappeenranta University of Technology. Information Technology. Available at: http://lutpub.lut.fi/bitstream/handle/10024/30505/TMP.objres.173.pdf;jsessionid=BBF914FCA2D086FAA16FB52000AF01AE?sequence=1 [Accessed: 26 June 2018]

Lacity, M., Solomon, S., Yan, A., & Willcocks, L. (2011). Business Process Outsourcing Studies: A Critical Review and Research Directions. Journal of Information Technology. 26(4), pp. 221-258. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/905644051/fulltextPDF/264178207A94446EPQ/1?accountid=27292 [Accessed: 5 July 2018]

Lacity, M., Willcocks, L. (2015). What Knowledge Workers Stand to Gain from Automation. Harvard Business Review. [online]. Available at: https://hbr.org/2015/06/what-knowledge-workers-stand-to-gain-from-automation [Accessed 18 Jan. 2018]

Lacity, M., Willcocks, L. & Craig, A. (2015a). The IT function and robotic process automation. The Outsourcing Unit Working Paper Series 15/05. The London School of Economics and Political Science. [online]. Available at: http://eprints.lse.ac.uk/64519/1/OUWRPS_15_05_published.pdf [Accessed 20 June 2018]

Lacity, M., Willcocks, L. & Craig, A. (2015b). Robotic Process Automation at Xchanging. The Outsourcing Unit Working Paper Series 15/03. The London School of Economics and Political Science. [online]. Available at: https://www.xchanging.com/system/files/dedicated-downloads/robotic-process-automation.pdf [Accessed 24 Aug. 2018]

Lacity, M., Willcocks, L. (2016). Robotic Process Automation at Telefónica O2. Mis Quarterly Executive 2016 Mar, Vol.15(1), pp. 21-35. [online]. Available at: https://wilma.finna.fi/lut/PrimoRecord/pci.wos000372081800002 [Accessed 24 Feb. 2018]

Lehväslampi, E. (2018). Interview. [12 July 2018]

Lintukangas, A. (2017). Improving indirect procurement process by utilizing robotic process automation. Master's Thesis. Lappeenranta University of Technology, School of Business and Management. Available at: http://lutpub.lut.fi/bitstream/handle/10024/143385/Lintukangas_Annika%2003082017.pdf;jsessionid=2BF8F7884D622FB76C02DF43E2DC8998?sequence=2 [Accessed 8 Feb. 2018]

Maventa. (2018). Maventa verkkolaskutuksen ominaisuudet. [online]. Available at [Finnish]: https://maventa.com/verkkolaskutus/ominaisuudet/ [Accessed 9 July 2018]

Mezei, J. (16.11.2016). Machine Learning in Analytics. LUT Lecture. [Accessed 27 May 2018]

Moffitt, K.C., Rozario, A.M., Vasarhelyi, M.A. (2018). Robotic Process Automation for Auditing. Journal of Emerging Technologies in Accounting. Vol.15. [online]. Available at: https://wilma.finna.fi/lut/PrimoRecord/pci.scopus2-s2.0-85051403409. [Accessed 26 Sep. 2018]

Mussalo, P. (2018). E-mail conversation. [e-mail]. [25 Mar. 2018]

Office. (2018). Overview of connecting to (importing) data. [online]. Available at: https://support.office.com/en-us/article/overview-of-connecting-to-importing-data-c0ad7aec-ff1a-4e48-9c21-dc18a102433f [Accessed 3 Aug. 2018]

Palkeet. (2018). Automatisaatiolla tehokkaampia palveluja. [online]. Available at [Finnish]: https://www.palkeet.fi/yhdessa-kehittaen/digitalisaatio.html [Accessed 11 July 2018]

Palkeet. (2018a). Palkeet ja Valtori tekoäly-yhteistyöhön. [online]. Available at [Finnish]: https://www.palkeet.fi/ajankohtaista/palkeet-ja-valtori-tekoaly-yhteistyohon.html. [Accessed 16 Aug. 2018]

Penttinen, E. (2008). Electronic Invoicing Initiatives In Finland And In The European Union – Taking The Steps Towards The Real-time Economy. Helsingin kauppakorkeakoulu. [online]. Available at: http://epub.lib.aalto.fi/pdf/hseother/b95.pdf [Accessed 6 June 2018]

Penttinen, E., Kasslin, H., Asatiani, A. (2018). How To Choose Between Robotic Process Automation And Back-End System Automation?. Twenty-Sixth European Conference on Information Systems (ECIS2018), Portsmouth,UK, 2018. [online]. Available at: https://www.researchgate.net/profile/Aleksandre_Asatiani/publication/324918928_How_to_Choose_between_Robotic_Process_Automation_and_Back-End_System_Automation/links/5aeb19230f7e9b837d3c7a96/How-to-Choose-between-Robotic-Process-Automation-and-Back-End-System-Automation.pdf [Accessed 26 Apr. 2018]

PowerBI. (2018). Business intelligence like never before. [online]. Available at: https://powerbi.microsoft.com/en-us/ [Accessed 26 June 2018]

PR Newswire. (2017). Global Robotic Process Automation (Tools, RPA Services) Market 2017-2022. [online]. Available at: https://search-proquest-com.ezproxy.cc.lut.fi/docview/1947363825?pq-origsite=primo [Accessed 29 May 2018]

Pro-liitto. Taloushallintoalan työehtosopimus 1.11.2016–31.10.2017. [online]. Available at [Finnish]: https://www.proliitto.fi/sites/default/files/user_files/Tessit/TES2016_2018/taloushallintoalan_tes_2016-2017_021116.pdf [Accessed 21 June 2018]

Qlik. (2018). Putting an end to analytics blind spots. That's the Associative Difference. [online]. Available at: https://www.qlik.com/us [Accessed 26 June 2018]

Rama, G., Kak, A. (2015). Some structural measures of API usability. Software: Practice and Experience. Volume 45(1), pp. 75-110. [online]. Available at: https://onlinelibrary-wiley-com.ezproxy.cc.lut.fi/doi/full/10.1002/spe.2215 [Accessed 31 May 2018]

Slaby J., Fersht, P. (2012). Robotic Automation Emerges as a Threat to Traditional Low-Cost Outsourcing. HfS Research Ltd. [online]. Available at: https://www.horsesforsources.com/wp-content/uploads/2016/06/RS-1210_Robotic-automation-emerges-as-a-threat-060516.pdf [Accessed 24 Feb. 2018]

Taloushallintoliitto 2017. (2018). Tilitoimistoala Suomessa. [online]. Available at [Finnish]: https://taloushallintoliitto.fi/tietoa-meista/tutkimuksia-ja-tietoa-alasta/tilitoimistoala-suomessa [Accessed 27 June 2018]

Taloushallintoliitto 2018. (2018). Toimialan liikevaihto jatkoi kasvuaan vuonna 2017. [online]. Available at [Finnish]: http://uutiset.taloushallintoliitto.fi/news/toimialan-liikevaihto-jatkoi-kasvuaan-vuonna-2017-300293 [Accessed 27 June 2018]

Toivonen, J. (2016). Robottiohjelmat ottavat palan kaikkien työstä – tylsä työ vähenee mutta katoavatko työpaikat?. YLE. [online]. Available at [Finnish]: https://yle.fi/uutiset/3-9268925 [Accessed 26 Apr. 2018]

Vanhala, M. (2016). Lecture 9: Reliability and validity of quantitative research. LUT Lecture. [Accessed 28 Aug. 2018]

Vantaa BI 2018. (2018). Financial shared services centre 2016-2018. Vantaa’s Business Intelligence software. [online]. [Accessed 27 May 2018]

Vantaa BI 2018a. (2018). Financial shared services centre 2019 estimate. Vantaa's Business Intelligence software. [online]. [Accessed 26 Sep. 2018]

Vantaa BI 2018b. (2018). City of Vantaa departments 2017-2018. Vantaa's Business Intelligence software. [online]. [Accessed 27 May 2018]

Vantaa 2017. (2017). Talousarvio 2018 – Taloussuunnitelma 2018-2021. [online]. Available at [Finnish]: http://www.vantaa.fi/instancedata/prime_product_julkaisu/vantaa/embeds/vantaawwwstructure/136268_Talousarvio_2018_taloussuunnitelma_2018-2021.pdf [Accessed: 26 Apr. 2018]

Vilko, J. (2016). Business Research Methods – Basics of qualitative research approach. LUT Lecture. [Accessed 26 Mar. 2018]

Warsaw Local. (2017). Average Salary in Poland. Warsaw Local. [online]. Available at: https://warsawlocal.com/average-salary-in-poland/. [Accessed: 17 July 2018]

World Bank. (2018). World Development Indicators. [online]. Available at: http://databank.worldbank.org/data/source/world-development-indicators# [Accessed: 31 July 2018]

W3C. (2016). Extensible Markup Language (XML). [online]. Available at: http://www.w3.org/XML/ [Accessed: 26 June 2018]

Zarkadakis, G., Jesuthasan, R., Malcolm, T. (2016). The 3 Ways Work Can Be Automated. Harvard Business Review. [online]. Available at: https://hbr.org/2016/10/the-3-ways-work-can-be-automated?referral=03759&cm_vc=rr_item_page.bottom. [Accessed 26 Apr. 2018]

Appendices

Appendix 1. Asatiani's list of processes in financial administration.

Asatiani (2016, 43)

Code	Process name
P1	Client register maintenance
P2	Product register maintenance
P3	Sending sales invoices
P4	Handling of sales invoices
P5	Sending note of complaint
P6	Sales ledger maintenance
P7	Supplier register maintenance
P8	Receiving purchase invoices
P9	Handling purchase invoices
P10	Handling purchase, travel and other costs
P11	Purchases ledger maintenance
P12	Personnel register maintenance
P13	Basic payroll data maintenance
P14	Payroll calculations
P15	Preparation of balance sheet and income statement
P16	Preparation and sending of VAT
P17	Preparation and sending of annual salary reports
P18	Preparation and sending of annual pension insurance reports
P19	Periodic VAT payments
P20	Salary payments
P21	Payments for purchases, travel and other expenses
P22	Monthly payroll tax payments

Appendix 2. Comparison of Robotic process automation, cognitive automation and social robots by Zarkadakis, Jesuthasan & Malcolm.

Zarkadakis, Jesuthasan & Malcolm (2016)

Which Automation Technology Is Right for Your Business?

	ROBOTIC PROCESS AUTOMATION	COGNITIVE AUTOMATION	SOCIAL ROBOTICS
Task type	• High volume • Low complexity • Routine	• Complex • Exploratory • Nonroutine • Decision-supporting	• Mixed routine and nonroutine • Collaborative
Operational mode	• Instruction-based • Likely to be further enhanced with machine learning	• Machine learning • Deep nets • Hybrid AI • Needs data and human trainers to learn	• Learning from human interaction and data
Application scope	• Wide • Can automate tasks of business processes	• Focused • Targeted to specific data sets • Tasked to deliver specific outputs (no artificial general intelligence yet)	• Wide • Can leverage human productivity across a spectrum of activities and expertise
Disruption in job definition	• Low to Medium	• High	• Medium to High
Product offerings	• Maturing • Off-the-shelf	• Emerging • Some ready to use (e.g., image/speech recognition)	• Maturing • Off-the-shelf
Cost to implement and maintain	• Low	• High	• Medium/High
Time to implement	• Weeks	• Months	• Months
Return on investment	• High • Can fit the current operational and business models • Can reduce need for some offshoring	• High • Potential to transform operational and business models	• High • Can significantly enhance productivity and efficiency

Appendix 3. Interview Questions of interview 1 in Finnish.

1. Millaisiin tehtäviin ostolaskutus jakautuu? (Kuuluuko matkalaskut tänne)

2. Talouspalvelukeskus jakautuu kirjanpitoon, ostolaskuihin, myyntireskontraan ja laskutuspalvelun tulosyksikköön. Ovatko kaikki näistä ottaneet ohjelmistorobotiikan käyttöönsä ja missä tehtävissä?

3. Voisinko saada jonkinlaisen kustannusarvion, paljonko esim. yksittäisen ostolaskun käsittely maksaa ilman robottia.

4. Mitä tekniikkaa käytettiin ennen robottia?

5. Miten robotit ovat onnistuneet; mitkä olivat tavoitteet ja onko ne saavutettu. Muistaakseni robotit käsittelivät n. 20% kaikista laskuista: onko tämä suunniteltua vähemmän? Robotilta kului laskuun muutama sekunti.

6. Onko työntekijämäärä muuttunut, onko aikaa säästynyt, ovatko virheet vähentyneet. Kuinka paljon robotti vie sen hallitsevien työajasta? (Jos vie esimerkiksi 33% esimiehen ajasta ja säästää 50% kahden työntekijän ajasta, niin onko lisensseineen kannattavaa?)

7. Mitä ongelmia robotit ovat kohdanneet? Ainakin alv:n löytäminen.

8. Millainen palvelumalli robotiikalla on käytössä? Jokaisesta muutoksesta ohjelmointiin joutui kai maksamaan erikseen. Maksetaanko tämän lisäksi aina lisenssi vuodeksi? Maksaako vuosilisenssi alle yhden työntekijän palkan.

9. Jos jokin tietty virhe/ongelma toistuu noin 5 kertaa päivässä, niin kannattaako RPA:n korjata tällaista virhettä vai antaa tämän vain ohjata nuo laskut ihmiselle?

10. Robotin ongelmat verrattuna e-laskuun. Esimerkiksi hajonta laskujen muodossa: vaikuttaako robottiin yhtä paljon kuin e-laskuun?

11. Minkä hintaisia tehtävät ovat nykyisellään. Esim paperinen ostolasku, ostoverkkolasku, paperinen myyntilasku, myyntiverkkolasku, palkkatosite, toimittajan tilinavaus, huomautuksen lähettäminen (2-3min?), juoksevan kirjanpidon kirjaus.

12. Minkälaisia laskuja Rondo ei pysty käsittelemään? Mitkä vaiheet Rondo osaa tehdä?

Appendix 4. Interview Questions of interview 2 in Finnish.

1. Tuleeko suurin osa laskuista verkkolaskuna? (Tarkkakin osuus kelpaa toki)

2. Onko ostolaskuprosessin hintaa per lasku arvioitu? (Ja onko eri arviota esim. ostotilauslaskulle tai paperilaskulle? Tässä siis riittää tieto, onko hinta-arviota tehty; varsinaisia euroja ei ole pakko antaa)

3. Laskun hyväksyminen (sisältäen satunnaiset uudelleenreititykset ja itse tehdyt ALV-korjaukset) vei arvioni mukaan keskimäärin noin 20s per lasku, eli tunnissa saisi hyväksyttyä arviolta 200 laskua. Onko tämä mielestäsi realistinen arvio?

4. Osaatko arvioida, kuinka monessa prosentissa laskujen käsittelyssä tapahtuu inhimillinen virhe? (Tämä voi olla toki mahdotonta arvioida)

5. Voinko käyttää kuviota nimeltä ”ostolaskuprosessi”, joka löytyy G:ltä vai onko se salainen?

6. Tarvitseeko ostotilauslaskuja tarkistaa vai onko niissä aina oikea ALV ja oikea reititys?

7. Missä järjestyksessä robotit suorittivat tehtävänsä (oliko siis neljä vaihetta, jotka robotti tekee seuraavassa järjestyksessä: oikeellisuustarkastus, reititys, kirjaus, ALV-tarkastus)

8. Osasiko robotti tarkistaa, onko päivämäärä tai kuukausi oikein?

9. Oliko IT-osasto mukana robotiikkaprojektissanne?

10. Osasiko robotti täyttää tiliöintirivejä Rondossa perustuen ohjausexceleihin? Esimerkiksi sähkölaskuissa tekeekö robotti tiliöintirivit vai tekeekö Rondo ne automaattisesti ja robotti vain tarkistaa ne? (Ymmärsin [redacted]n haastattelussa robotin pystyvän tähän)