Aalto University
School of Business

HUMAN-COMPUTER INTERACTION AND ROLE ALLOCATION IN INFORMATION-INTENSIVE WORK PROCESSES: ROBOTIC PROCESS AUTOMATION IN FINANCIAL ADMINISTRATION WORK

Case: Company X

Master's Thesis
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Information and Service Management
Spring 2018

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Abstract of master's thesis

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Title of thesis Human-computer interaction and role allocation in information-intensive work processes: Robotic process automation in financial administration work

Degree Master of Science in Economics and Business Administration

Degree programme Information and Service Management

Thesis advisor Esko Penttinen

Year of approval 2018 **Number of pages** 85 **Language** English

Abstract

The aim of this study is to provide a more detailed view into how the interplay between human and computer manifests itself in contemporary information-intensive work processes, specifically in financial administration work.

Literature about information-intensive work, distributed cognition, mindful and mindless action, and epistemic and pragmatic action are reviewed to provide a thorough understanding about the cognitive processes, physical actions, and data processing activities required to carry out work tasks and processes.

This study follows qualitative case study and grounded theory methods for inductive theory-building, and uses semi-structured interviews and direct user observation as research data collection techniques. One of the Case Company X's business units is examined in the empirical part of the study, which provides a view into information-intensive tasks and processes in financial administration shared service centre. Financial administration with its various rule-based tasks and processes is an ideal field of work to study, as new technologies such as robotic process automation and machine learning can be implemented effectively to the tasks and processes that follow to large extent certain step-by-step procedures.

By analysing the gathered data, it made possible to characterise many common financial administration tasks with certain characteristic profiles. This allowed to identify in which tasks human labour can be augmented or substituted with automation, but also what are human agents' areas of strength.

As this study shows, automation tools can be best applied to tasks that involve mindless, rule-based processing of data and information. If such task is also considered to be in a support role and requiring merely pragmatic actions to carry out the tasks, it is even more potential candidate for automation. However, if a task calls for applying judgment mindfully, and also requires epistemic actions to perform it, then a human agent should carry out such task.

Based on the existing literature and empirical findings, a framework is formed that illustrates contemporary information-intensive operations on a general level. These insights and findings provide a new theoretical base to expand on, and clarify for managers what is the best course of action to take when automating information-intensive tasks and processes.

Keywords human-automation interaction, distributed cognition, mindful and mindless action, pragmatic and epistemic action, automation of information-intensive processes, robotic process automation

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Maisterintutkinnon tutkielman tiivistelmä

Tekijä Joona Ruissalo

Työn nimi Ihmisen ja koneen vuorovaikutus ja roolitus informaatiointensiivisen työn prosesseissa: Ohjelmistorobotiikka taloushallintotyössä

Tutkinto Kauppatieteiden maisteri

Koulutusohjelma Information and Service Management

Työn ohjaaja Esko Penttinen

Hyväksymisvuosi 2018 **Sivumäärä** 85 **Kieli** Englanti

Tiivistelmä

Tämän tutkimuksen tarkoituksena on lisätä ymmärrystä siitä, millä tavalla vuorovaikutus ihmisen ja koneen välillä ilmenee nykyaikaisen informaatiointensiivisen työn prosesseissa erityisesti taloushallinnon kontekstissa.

Teoriaosuudessa käydään läpi informaatiointensiivistä työtä, hajautettua kognitiota, tiedostavaa ja tiedostamatonta toimintaa sekä episteemistä ja pragmaattista toimintaa. Näiden avulla saadaan muodostettua ymmärrys kognitiosta, fyysisistä toiminnoista ja tiedonkäsittelyprosesseista, joita vaaditaan työtehtävien suorittamiseen.

Tässä tutkimuksessa käytetään kvalitatiivisia tapaustutkimus- ja grounded theory -metodeja sekä datankeruumenetelminä puolistrukturoituja haastatteluita ja suoraa havainnointia. Induktiivisen päättelyn avulla pyritään luomaan uutta teoreettista tietoa. Tutkimuksen empiirisessä osuudessa tarkastellaan case-yritys X:n yhtä liiketoimintayksikköä ja sen taloushallinnon palvelukeskuksen informaatiointensiivisiä työtehtäviä ja prosesseja. Taloushallintoala ja sen monet sääntöpohjaiset työtehtävät ja prosessit soveltuvat erityisen hyvin tutkimuskohteiksi, sillä uusia teknologioita, kuten ohjelmistorobotiikkaa ja koneoppimista, voidaan ottaa tehokkaasti käyttöön työtehtävissä ja prosesseissa, jotka seuraavat pitkälti vaihe vaiheelta etenevää järjestystä.

Analysoimalla kerättyä dataa on mahdollista kuvata useita yleisiä taloushallinnon tehtäviä tietyillä ominaisuusprofiileilla. Tämä mahdollistaa niiden tehtävien tunnistamisen, missä ihmistyötä voidaan täydentää tai korvata automaatiolla sekä ihmisten vahvuusalueiden tunnistamisen.

Tutkimuksessa osoitetaan, että automaatiotyökaluja voidaan parhaiten käyttää tehtävissä, joissa on tiedostamatonta ja sääntöpohjaista tiedonkäsittelyä. Mikäli tämänkaltainen tehtävä on lisäksi tukitoiminto ja vaatii ainoastaan pragmaattisia toimintoja tehtävän suorittamiseksi, on se vielä potentiaalisempi kohde automatisoitavaksi. Jos työtehtävä puolestaan vaatii tiedostavaa harkintaa ja episteemisiä toimia, sen käsittelyn hoitaa parhaiten ihminen.

Yhdistämällä olemassa olevaa kirjallisuutta ja tämän tutkimuksen empiiriset löydökset on mahdollista muodostaa viitekehys, joka havainnollistaa nykyaikaisen informaatiointensiivisen liiketoiminnan yleisellä tasolla. Nämä näkemykset ja löydökset tarjoavat uuden teoreettisen pohjan sekä selventävät yritysjohdolle, miten informaatiointensiivisten työtehtävien ja prosessien automatisointia tulisi lähestyä.

Avainsanat ihmisen ja koneen vuorovaikutus, hajautettu kognitio, tiedostava ja tiedostamaton toiminta, pragmaattinen ja episteeminen toiminta, informaatiointensiivisten prosessien automatisointi, ohjelmistorobotiikka

Acknowledgements

I want to thank my supervisor Esko Penttinen as well as Aleksandre Asatiani for the invaluable support and guidance during the span of this study. I also want to thank my supervisors from the case company for the help they gave and making it possible to conduct this research. Likewise, I am thankful for the time and effort that the interviewed employees from the case company gave to make this study happen.

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1 Introduction

In the past couple of years, technologies such as robotic process automation, machine learning and artificial intelligence have reached a level of maturity when those have become applicable to business use (Horses for Sources, 2014; Willcocks & Lacity, 2016, p. 34). For instance, robotic process automation is said to transform back-office processes by removing manual, routine tasks from human specialists, thus making processes more efficient, and reducing costs (Institute of Robotic Process Automation, 2015, p. 10). As new automation tools have become available, it has opened up a new possibility for organisations to further enhance and improve current business processes. Therefore, it is no wonder that automation technologies such as robotic process automation, machine learning, and artificial intelligence have gained attention and keen interest of businesses who are more than willing to seize the new opportunity (cf. Willcocks and Lacity, 2016).

Moreover, as Moore's law indicates, computing power increases exponentially every 18 to 24 months (Moore, 1965). Hence, automation tools will become even more powerful and intelligent in the coming years as computing power increases and it opens up new possibilities to develop automation tools (Horses for Sources, 2016, p. 8-10). If the current pace in the increase of computational power is maintained, it can be predicted that in the near future automation tools will be significantly more advanced than currently and can handle even larger amount of data, make intelligent and accurate connections between different datasets, and process computations faster than today (Moore, 1965, p. 114). Therefore, it is highly likely, that the degree of automation will only increase in knowledge intensive digital service work such as back-office processes for example in financial administration (Institute of Robotic Process Automation, 2015, 2016; McKinsey Quarterly, 2016).

As these technologies spread throughout the world and are taken in use, those profoundly change how we take action and carry out our duties. The computers that we use both monitor as well as guide our actions, and even change our behaviour. (Rogers, 2012; Carr, 2011) Even though novel automation tools open up new avenues for business process improvement, business managers should be mindful of both the positive and negative effects of automation. As use and reliance on cognitive technologies that extend cognitive abilities increases, they modify how we cognise, what things we do, and how we do them (Dror & Harnad, 2008, p. 2-4 & 21). This raises the question how the roles of human and computer should be allocated in information-intensive operations, and how does the interplay between human and computer manifests itself in contemporary information-intensive work processes. Therefore, this study provides insight into how to best utilise the new wave of software-based automation by performing a task-level analysis, which sheds light to what are the ideal tasks to augment or substitute human labour with automation tools in work processes.

1.1 Research problem, gap and questions

As pointed out in the introduction, new automation software tools have gained considerable momentum in the past couple of years, which can be used to target the long tail of automation (Kingdon, 2014). This in turn has sparked strong interest among businesses that run information-intensive services, because they are now able to implement automation to processes and tasks in order to make those more efficient, and reduce errors at the same time (cf. Willcocks & Lacity, 2016). So far, relatively little attention has been given to examine and analyse information-intensive tasks to understand the actions taken in them, which would bring about deeper understanding of the work processes. Therefore, this study aims to fill the apparent research gap in the existing literature by taking a holistic perspective, and drawing understanding from the literature of information-intensive work and material, distributed cognition, mindful and mindless behaviour, and epistemic and pragmatic action to characterise work tasks performed in financial administration based on these concepts.

Although previous studies have focused on for example collective minding and IT appropriation in construction industry (Carlo, Lyytinen & Boland, 2012), how mindful and mindless action induce reliability when using complex information systems in dynamic contexts (Butler & Gray, 2006), and how to design information technology that supports distributed cognition (Boland, Tenkasi & Te'eni, 1994), no study has so far examined financial administration's information-intensive work processes on a task level, and how human-computer interaction manifests itself in these processes. Financial administration with its various rule-based tasks and processes is an ideal field of work to study, as robotic process automation and other emerging technologies such as machine learning can be implemented effectively to the tasks and processes that follow to large extent certain step-by-step procedures. Therefore, it is highly likely that these kinds of tasks are being further automated in the future, which is why creating understanding about the interplay between human and computer in this context is essential to appreciate the complexity of such operations.

Thus, the aim of this study is to develop objective ways to characterise information-intensive tasks, which enriches the understanding of the strengths and weaknesses of humans and computers in information-intensive operations. Drawing from the research problem and gap, the study sets to answer the following research question:

1. *How does the interplay between human and computer manifest itself in contemporary information-intensive work processes?*

To answer this, the first objective is to draw from the literature of information-intensive work, distributed cognition, mindful and mindless action, as well as epistemic and pragmatic action to provide a thorough understanding about the cognitive processes, physical actions, and data processing activities required to carry out work tasks and processes in the task environment.[1] These specific concepts are also used as characteristics to evaluate a sample of common information-intensive financial administration work tasks. Secondly, expert and manager interviews were conducted to gain deep insight into information-intensive back-office processes. In addition, a user observation was carried out to have a detailed view of a certain financial administration process so that the current roles of human specialist and computer become visible. This qualitative research data about information-intensive tasks and processes executed by human specialists and software automation tools is examined and analysed in the empirical part.

Thirdly, drawing from the understanding created based on the literature and analysis of the collected data, every task is profiled based on the set of characteristics. As tasks are profiled by certain characteristics, it is easier to assess whether a task is better suitable to be performed by a human specialist or a computer software, and if such task can be either augmented or substituted with automation. This will allow to form characteristic profiles for the tasks under review, ultimately indicating whether a certain information-

[1] I am indebted to Kalle Lyytinen for making me aware of the relevance of the theory on mindfulness and mindlessness in this research context, and likewise for Antti Salovaara concerning the theory on distributed cognition and epistemic and pragmatic action.

intensive task can be carried out either by a human specialist or computer software. Finally, these findings are discussed in the latter parts of the study, linking the empirical findings to existing literature. With the understanding of the tasks and work processes it is possible to form a framework that illustrates contemporary information-intensive operations on a general level.

1.2 Key concepts and abbreviations

This study reviews information-intensive financial administration work processes. Therefore, the following financial administration key concepts related to this study are described to understand what those are in general, and what kind of work those typically include. Also, central abbreviations for this study are listed:

<u>Debt collection process</u>

Debt collection process involves analysing delinquent account balances, corresponding and negotiating with the delinquent accounts, renegotiating terms of debt payback in case of a default account, and managing the default accounts. Debt collection process is an integral part of order-to-cash process. (APQC, 2017; Investopedia, 2017a)

<u>Order-to-cash (O2C) process</u>

Order-to-cash process comprises of these following main sub-processes: receiving and handling a sales order, generating a sales invoice, managing accounts receivable and cash management, and debt collection when needed. (Aberdeen, 2012, p. 11; ING, 2008)

<u>Purchase-to-payment (P2P) process</u>

Purchase-to-payment process includes several sub-processes: sending a purchase requisition, accepting and generating a purchase order, matching the purchase order to invoice, and approving and making a payment. Also contract and relationship management are important parts of the process. (Investopedia, 2017b; CIPS, 2006)

<u>Record-to-report (R2R) process</u>

There are multiple activities in the record-to-report process: reconciliating accounts, making adjusting journal entries, consolidating accounts, closing the general ledger at the end of each period, analysing financial statements, and forming several different reports for clients and third parties, for instance tax return documents. The R2R process is complex, as it requires involvement of several participants, and frequently includes information from several sources. For instance, O2C and P2P processes are tightly connected to R2R process, as those process and prepare the transaction data to be used for R2R purposes. (Brands, 2013, p. 56)

Shared service centre (SSC)

Shared service centre is a business unit that operates consolidated support activities, for instance accounting (Schulz & Brenner, 2010), and provides services for internal and external clients. Although SSCs add value through simple cost-cutting such as outsourcing, the main driver to restructure business units' support activities to be run in a SSC is that those become also core activities of SSC. This in turn encourages the development of new operational competencies. (Sako, 2010)

Abbreviations

AI	Artificial intelligence
AIS	Accounting information system
ERP	Enterprise resource planning
IT	Information technology
ML	Machine learning
RPA	Robotic process automation

1.3 Structure of the study

This study consists of altogether six sections. After the introduction, the study moves on to literature review section, which is divided into four subsections. In the first subsection, information-intensive work and digital material are examined, and in second subsection literature about human-computer interaction and distributed cognition will be presented, as well as theories of bounded rationality and frame problem. In the third subsection, the study moves on to review literature about mindful and mindless action, and then to examine epistemic and pragmatic action in the final subsection of the literature review.

In the third section, the methodology of the study as well as validity and reliability of methods and data will be justified. Fourth section begins by presenting the case study of

Company X’s business unit, moving on to the empirical findings based on interview and observation data. In the fifth section, both theory and empirical findings are discussed to understand the implications of the findings on information-intensive work, and then brought together to form a framework. Finally, in the sixth section, the study is concluded by presenting the main findings, recommendations, limitations of the study, and suggestions for further research.

2 Literature review

In this chapter, the focus is on laying out the theoretical groundwork for the later empirical part. Understanding the theoretical background of the topics being examined gives a sufficient understanding of the different characteristics that are used to evaluate suitability of an information-intensive task or a process to be performed by a human or a computer. Also, such understanding will help to assess the implications and changes in information-intensive work better if further automation such as RPA is implemented to business processes. As this study examines information-intensive work processes and tasks, literature about the nature of this line of work and material used in this line of work are also reviewed in the next section in order to understand those in more detail and to form a general picture about the field of work in question.

2.1 Work and material in information-intensive processes

This section discusses first information-intensive work and what counts as support or value-added work, then moving on to review algorithmic operations and digital material. This forms a foundation to discuss the characteristics of information-intensive business processes when the context and underlying factors are clear.

2.1.1 Information-intensive work

Before discussing information-intensive work and other types of work, it is best to begin by defining data, information, and knowledge, as those are essential to this section. Megill (2013, p. 67) defines data as a set of distinct, objective facts about events that have taken place, that can be stored for example on physical hard disks that are used in computers, electronic devices, and databases. When data is given relevance and purpose, and it is placed in a context or categorised, data becomes information as it gets meaning when this kind of judgment is applied. In turn, knowledge is the beliefs that result from assessing information and making judgments based on available data and information. Hence, distinguishing information work from knowledge work is important as those are very different. (Megill, 2013, p. 67)

Apte et al. (2010, p. 667) succinctly define work in information-intensive services to cover collection, storing, and processing of information, and also organising and using knowledge. Even though information-intensive processes such as P2P and O2C in financial administration work does include knowledge work to some extent, it is not the primary component of such work (cf. Davenport et. al, 1996, p. 55). The goal of financial administration processes such as P2P and O2C is to process data efficiently and accurately to be used in R2R process which aims to create new financial and operational information based on the processed data. In information-intensive services such as in financial administration the inputs of business processes are converted into outputs by following instructions thus making the work for the most part predictable and structured (Davenport et. al, 1996, p. 54-55). This information output can then be applied and used in other processes and as a basis in accumulating new knowledge and in making more informed decision. Therefore, in the context of financial administration information-intensive work can be defined as routine processing and manipulation of data to information, which also includes some elements of knowledge work.

The framework below in Figure 1 shows a classification of knowledge-intensive processes, but it also illustrates information-intensive processes such as transaction and integrative work:

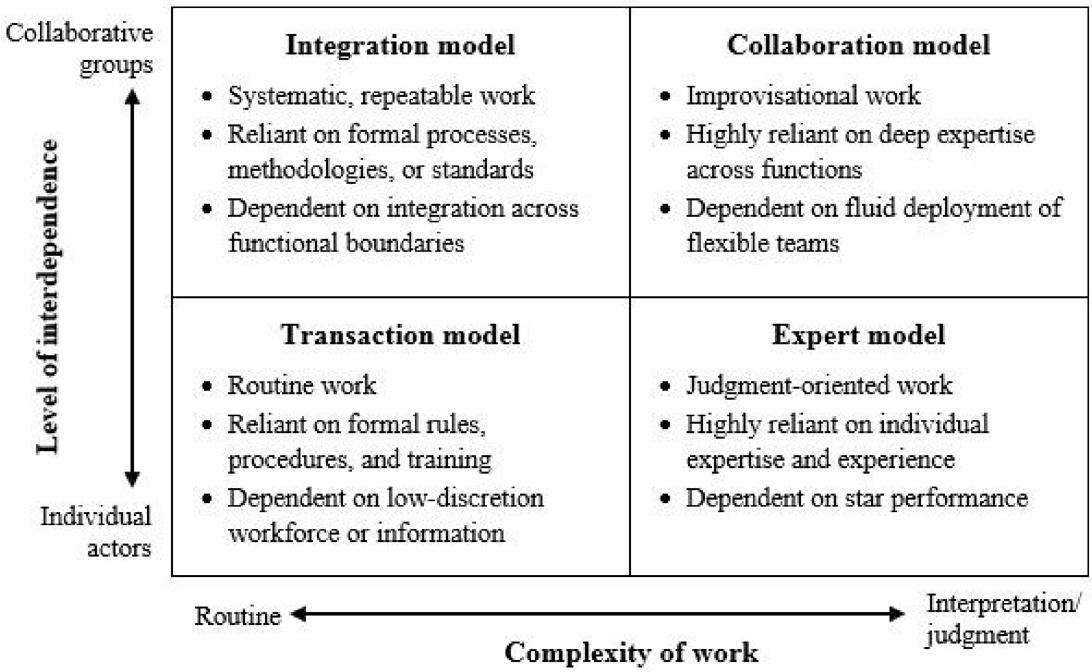

Figure 1. Classification structure for knowledge-intensive processes (Davenport, 2005, p. 27).

Framework in Figure 1 helps to characterize different types of work carried out in information- and knowledge-intensive processes overall. For example, the field of financial administration includes several different processes, such as O2C, P2P, and R2R, and not one of the processes can be classified solely into just one type of work as in the framework. However, specific tasks or activities within processes can be categorised to fall in one of the four categories.

Moreover, one additional factor to consider is the distinction between support and value-added work, as information-intensive work is often regarded as support work and knowledge-intensive work as value-added work. This is largely because of the characteristics of these two types of work: for example collection, validation, and manipulation of data that are part of information-intensive work are considered as non-value adding or support tasks, whereas activities such as delivering analysis of financial information and tax planning are seen as value adding (Holtzman, 2011, p. 53; Apte et al., 2010, p. 667). As defined earlier what constitutes as information-intensive work, knowledge work on the other hand requires drawing on prior knowledge and applying it in action to produce novel potential knowledge (Reinhardt et al., 2011, p. 158). Thereby, it is about producing something of value that calls for creativity and understanding, which is why knowledge work is considered to be value-adding as it connects information and places it into a context with appropriate use of different tools to achieve goals (Megill, 2013, p. 63 & 67). As it is illustrated in Figure 1, as complexity of work increases and the more it is required to make interpretations and apply judgment in tasks and activities, the more value-add that work is considered to be.

In addition, Hatano and Inagaki (1986, p. 262-263) define two different types of expertise: routine and adaptive. Routine experts carry out typical, recurring tasks in stable environments with high efficiency, while adaptive experts attempt to explore new possibilities, learn from new situations, and critically evaluate best courses of action. Moreover, Nonaka (1994, p. 15) draws a distinction between tacit and explicit knowledge, where tacit knowledge is personal and can not be expressed easily whereas explicit knowledge can be codified and communicated. Drawing from this discussion, the more an activity requires applying adaptive expertise and tacit knowledge to connect information and placing it into a context, the more it is regarded as value-added work, whereas support or non-value added work is linked with routine processing and manipulation of data to information. Next, algorithmic operations and digital material that are essential part of contemporary information-intensive work processes are discussed.

2.1.2 Algorithmic operations and digital material

Technologies such as robotic process automation, machine learning, and artificial intelligence that are increasingly implemented to a variety of different digital businesses processes in different organisations are changing how tasks and activities are performed in business processes (Willcocks & Lacity, 2016). These technologies are comprised out of algorithms, and as Domingos (2015) points out, in its essence an algorithm is a set of instructions that informs a computer how to execute a task. As algorithms are put in use and become interlinked in complex ways, those ultimately form algorithmic operations (Domingos, 2015). These algorithmic operations can process especially structured data much more accurately and faster than a human could, as a human reads and interprets text and symbols whereas for example RPA processes data in binary format – that is, in strings of zeros and ones. Therefore, automation of work that is considered as non-value added or support activities such as data processing makes it possible to speed up processes, decrease human error, improve the quality of data, and focus more on value-added work (Holtzman, 2011, p. 55). Hence, technology's function is often to reduce and eliminate repetitive, manual tasks and activities in processes (Megill, 2013, p. 62) and automation can be seen as a tool that allows to improve work processes and create efficiency and effectiveness to perform tasks and activities (Holtzman, 2011, p. 55; Megill, 2013, p. 62). In other words, existing human abilities are often augmented with technological artefacts (Brey, 2000), for instance in financial administration with automation tools such as RPA software.

Furthermore, it is important to consider the characteristics of digital material that algorithmic operations process, as contemporary financial administration processes are extensively run on AISs in which majority of data is in digital format. Digital material such as electronic invoices are either automatically processed by algorithmic operations or manipulated manually by the human specialists to form new information like financial figures and reports. Kallinikos et al. (2013, p. 358-360) define digital material as editable, interactive, reprogrammable, and distributable. As digital material is editable, it can be modified by deleting or adding content to it. Secondly, interactivity of digital material means that it is possible to for example explore how underlying information items are arranged. In AISs, this means that an accountant can drill down or up from specific account balance in the system and find out how the balance is accumulated. Thirdly, digital material is reprogrammable by other software, meaning that for instance RPA and algorithms that are in the essence digital material, can process and alter digital accounting material. Lastly, digital material is rarely stored within a single database or other source, making it distributed. Thus, digital material holds different attributes than physical material such as paper and other non-digital records, which allows to come up with new, innovative ways of arranging business processes. However, processes of managing and modifying digital material need to be controlled so that the outcomes are stable and reliable. (Kallinikios et al., 2013, p. 364-365) These discussed concepts and characteristics of information-intensive work, algorithmic operations, and digital material form a basis to discuss human-computer interaction in the upcoming section.

2.2 Human-computer interaction

In order to form a general framework of the interactions between humans and computers, this section will provide a review of central concepts of human-computer interaction for this study. Understanding of distributed cognition, frame problem, and bounded rationality help in part to form a holistic representation of how humans and computers can support each other in complex information-intensive tasks and activities.

2.2.1 Distributed cognition

Due to significant development of information technology, human-computer interaction has become one of the most important and fastest growing research questions. There are hardly any areas of human activity where computers would not be used at least indirectly. (Oulasvirta, 2011, p. 41) Distributed cognition is one of the modern theoretical approaches in human-computer interaction, and the approach studies cognitive phenomena in relation to individuals, artefacts, and external and internal representations (Hutchins, 1995a, b; Rogers, 2012), and its theoretical and analytical basis originates from cognitive science (Perry, 2010, p. 388). It typically involves portraying a cognitive system, which involves studying interactions among people, artefacts used by them, and the environment in which they are working (Rogers, 2012, p. 37), which is unusual in that it studies all within a common framework (Perry, 2010, p. 388). Distributed cognition was proposed as a radically novel paradigm for reassessing all domains of cognition, and furthermore the same conceptual framework to be utilized to a variety of cognitive systems, including socio-technical systems in general (Hutchins, 1995). Thus, as a framework, distributed cognition gives unique view into how technology and socially created media of communication act based on and substantially change representations, and thus, carry out computations or information processing activities (Perry, 2010, p. 389). This view expands the boundaries of traditional cognitive science as it includes a broader network of ecological relations assisting an individual cogniser (Gureckis & Goldstone, 2006).

People who interact with computers broadly develop a wide range of smooth, efficient, learned behaviours for performing their routine communicative activities. Yet, this interaction is extremely cognitive. The skills are utilised within a context of problem-solving, and the skills themselves include symbolic information processing. For example, even using a text-editing software that is one of the most routine activities performed on a computer requires to interpret instructions, devise command sequences, and communicate the commands to a computer. (Card, Moran & Newell, 1983, p. 15) In organisations, cognition is a distributed phenomenon, in which organisation's individual members draw upon their experience, outline plans, or perform actions. In distributed cognition, a group is a certain number of autonomous agents who take action independently, but recognise interdependencies between them. When individuals think and take action in such ways that take into account others in the organisation and their interdependencies, it will lead to the emergence of coordinated outcomes in the organisation. (Boland, Tenkasi & Te'eni, 1994) In distributed cognition, the process of thinking is considered to transcend the individual human mind and therefore viewed as distributed, either across a group's members or simultaneously with external artefacts in the environment (Hutchins, 1995a, b). Cognising itself is a mental state, as it encompasses thinking, understanding, and knowing. Systems without mental states, for instance cognitive technology, can occasionally support human cognition, but that does not make such technologies cognisers. Cognisers – or in other words human agents – can offload a part of their cognitive abilities onto cognitive technology, which extends their capacity to perform beyond their own brain power's limits. As cognitive technology extends the power and scope of cognition, it allows the human agents to think quicker and further, and better utilise language, computers, the Internet, software agents, algorithms, and additionally whatever that is in other cognisers' heads. (Dror & Harnad, 2008)

However, distributed cognition aims to understand how intelligence manifests at the systems level and not at the individual cognitive level (Hutchins, 1995a), and as Perry (2010, p. 389) points out, the combination of people and artefacts in a particular situation "contribute to the functional system of activity, which includes all of the representation-carrying and representation-transforming entities involved in the problem-solving activity". From a computational view, the functional system brings into use inputs in the form of representations, and transforms the representations by disseminating them to the units of the system. By using the external symbol system in a distributed cognitive analysis allows to capture the elements of processing – both the representations and processes – that transform system inputs into outputs for certain tasks. In several situations, human agents bring together the distributed representations and processes which are coordinated through social mechanisms. (Perry, 2010, p. 390)

In line with Perry's (2010) description, Kirsh's (2006, p. 258) comprehensive, but concise description illuminates the core idea of the overall domain of distributed cognition: "*The study of distributed cognition is very substantially the study of the variety and subtlety of coordination. One key question which the theory of distributed cognition endeavors to answer is how the elements and components in a distributed system – people, tools, forms, equipment, maps and less obvious resources – can be coordinated well enough to allow the system to accomplish its tasks*". With this statement, Kirsh (2006) indicates that coordination is essential in distributed cognition and it takes place at all levels of analysis. Even still, problem-solving expertise does not only lie in the knowledge and skills within individuals, but in how these individuals are organised, and how well they are able to coordinate work amongst themselves (Perry, 2010). Therefore, distributed cognition offers an effective method to analyse and describe the coordination and interdependencies of individual cognisers and components in the overall complex distributed system. Hence, this study focuses on drawing upon the domain of distributed cognition to understand how human agents cognise and use different artefacts, such as computer software, to support their activities and tasks in information-intensive work environment.

Important aspect of distributed cognition systems is that whether the system in question is tightly or loosely coupled. From an individual human agent's perspective, performed actions are local and closely coupled to the local environments, and by externalising thought and intention human agents deploy external sources of cognitive capacity. Distributed cognition is the outcome when external processes are closely coupled. Two entities are closely coupled when those interact reciprocally, or in other words, changes in the other entity cause changes in the another one, and this process unravels in a way that the state trajectory of the other cannot be explained without examining the state trajectory of the another one. (Kirsh, 2006, p. 250) However, as Perry (2010) demonstrates, there are clear differences between tightly and loosely coupled systems. Examples of tightly coupled systems are for example ship navigation (cf. Hutchins, 1995a), aircraft cockpits (cf. Hutchins, 1995b), and other problem-solving situations that are more limited. In contrast, the nature of work in loosely coupled systems is very contingent, unpredictable, and it is highly context-dependent. Furthermore, the participants make use a larger set of representational resources that are available in the local environment when beginning a particular activity. (Perry, 2010, p. 396)

The clearest difference when comparing tightly and loosely coupled organisational systems is the access to resources. An example of a tightly coupled system is navigation, as the set of resources applied in the process is fixed and restricted, and external agents can not involve themselves in the system. In contrast, agents in loosely coupled systems might utilise a broader set of resources that may not have been specified initially or known to be at one's disposal at the beginning of the activity. The second difference is in how the problems are structured. In tightly coupled systems tasks are recurring and agents have practised how to perform these repetitive tasks, which makes the problems expected and well-structured even prior to solving a particular problem, whereas in loosely coupled systems problems tend to be generally poorly structured, and become well-structured only when the agents begin to perform activities and during problem-solving learn more about the problem. (Perry, 2010, p. 391-393, 396)

Continuing with the differences, the third distinction between these two systems lies in the organisational structure and dynamics of problem-solving. The coordination of activity differs based on the employed methods, and in tightly coupled organisational systems such as in navigation, the organisation has predetermined methods – or in other words, modes of operation – that are enforced by regulations, which makes the division of labour well understood on certain tasks. In loosely coupled systems, all of the communication pathways are not properly specified before problem-solving, and it is likely that predetermined methods constrain the organisation only partially. Additionally, there might be few definitive organisational structures, and the communication pathways, artefacts, and agents available are probable to change over time. Furthermore, some processes might be specified formally, but many are created in an *ad hoc* manner, and individual agents might be left to decide what actions should be taken as the state of affairs change. (Perry, 2010, p. 394-396)

The two different systems also differ when it comes to the before-mentioned problem dynamics, which has implications how strategies for problem-solving develop and enter the workplace culture. Tightly coupled systems have unchanging, stable processes, and those can remain unchanged even though activities with short duration in a particular process are performed multiple times. In loosely coupled systems, the activities performed – for instance design development and contract negotiations – span over a longer time period, and over time it is likely that methods develop, possibly even within a particular activity. As it was already touched upon, the final difference lies in the activity cycle's duration, which differs significantly between tightly and loosely coupled organisational systems. In tightly coupled systems the duration of problem-solving is relatively short, whereas in loosely coupled systems the time-span varies and is much longer. (Perry, 2010, p. 396-397)

Drawing from the descriptions of tightly and loosely coupled systems those can be viewed as information processing systems that both have resemblance in the high-level cognitive structure. However, as the descriptions imply, the technical resources, goals, and contexts of use when work is performed by these two different systems might be very different. (Perry, 2010, p. 397) As Poirier and Chicoisne (2006, p. 27 & 41) note, a distributed cognitive system can be truly determined as one when the interaction between the system's elements give rise to a novel cognitive property. Even then in some situations it is possible that human epistemic limitations inhibit to comprehend the emerging properties from collective behaviour, which means that the intrinsic value of the distributed cognitive property would be unattainable (Poirier & Chicoisne, 2006, p. 27 & 41) The limitations of human cognition and algorithmic operations are discussed in the upcoming sections.

2.2.2 Frame problem and bounded rationality

Two concepts that are closely connected with distributed cognition are frame problem and bounded rationality. These two concepts are important in forming a more thorough understanding about the strengths and weaknesses of humans and computers, as both support each other in alleviating frame problem or bounded rationality. Next, both of these limitations will be discussed.

The constraints in the capabilities of a human agent to process information is called bounded rationality, and these limitations of humans' rationality constrain optimal or even sufficient adaptation to complex environments (e.g., Simon, 1972; Simon, 1991). When a human specialist is writing software applications or updating its rules, in most cases there is a clear idea of what is needed to be achieved with it and the environment in which it will be operating, which is why Conceicão et al. (1998) call software as a codification of human knowledge. In order to achieve reliable performance, the operating conditions and needs of the user need to be known so that those can be accommodated in the design phase which is not normally a problem. The situation changes when the system has to work in situations and conditions that are not as well-defined, or because exceptions – situations, that aren't expected and occur seldom – happen occasionally. (Vernon, 2014, p. 7-10) For example, if a purchase invoice without automatically pre-filled reference number comes up in AIS, an automation software application should either be able to find the correct identification number based on the historical purchase order data or notify the human specialist to deal with the exception later.

This kind of situation is something that human specialists face and deal with routinely and continuously, but a rule-based software can not alone deal with such task if the data on the purchase invoice is not structured, and thus it needs to inform the human specialist about the exception. The reason why human specialists can act in these situations self-reliantly to carry out independent adaptive anticipatory actions is because of the ability to cognise – in other words, rely on their cognitive capability (Vernon, 2014, p. 2-3). However, human cognition is bounded one way or another and the only option to increase it is with the use of cognitive artefacts (Poirier & Chicoisne, 2006, p. 232) such as computers and software.

On the other hand, algorithmic operations that are used in information-intensive work are limited as well due to frame problem. In AI research frame problem is defined as "the challenge of representing the effects of action in logic without having to represent explicitly a large number of intuitively obvious non-effects" (Stanford Encyclopedia of Philosophy, 2016; McCarthy & Hayes, 1969). Even though one possibility to alleviate the frame problem is to program algorithmic operations to recognise all possible combinations, it would lead to enormous number of rules making this option an immense task both to program and compute. Without having every possible option and outcome in its rule set, algorithms can not comprehend and overcome exceptions that are not defined in its set of instructions. In the face of an unexpected situation human intervention is required due the frame problem. (McCarthy & Hayes, 1969) Therefore, bounded rationality and frame problem explain well the limitations of human sense-making and algorithmic operations, but as mentioned there are ways to work around such limitations. Being aware of these limitations helps to assess how to improve the work of human agents as well as algorithmic operations, as one supports the another in alleviating respective limitations.

2.3 Mindful and mindless action

This section will provide theoretical grounds to mindful and mindless actions first at the individual level and then on the organisational level. As Butler and Gray (2006, p. 217) well put it, the concept of mindfulness provides a theoretical basis to understand how individuals and organisations can seek to efficiently create processes, practices, and information systems from complex, uncertain components to accomplish reliable outcomes. Therefore, theory of mindful and mindless action supplements the understanding on what are the strengths and weaknesses of human and algorithmic operations and how those contribute to an organisation's functioning.

To begin with, at the individual level mindful behaviour is characterised by the ability to continuously create and use new categorisation schemes in perception and interpretation of the surrounding environment and the world in general (Langer, 1997, p. 4). Mindfulness is a state of mind in which an individual is implicitly and consciously aware of the content and context of information. In such state, the individual is open to novelty and actively creates categories and distinctions. (Langer, 1992, p. 289) According to Langer (1997, p. 23), this mindful behaviour is fostered by five different constituent parts, which Sternberg (2000) describes as five states of a mindful cognitive style: (1) openness to novelty, (2) alertness to distinction, (3) sensitivity to different contexts, (4) awareness of multiple perspectives, and (5) orientation in the present (Langer, 1997, p. 23). By being aware of multiple points of view, an individual is able to engage in dialectical thinking – in other words, to see things from different or opposing perspectives (Langer, 1989). In contrast, mindlessness is a state of reduced attention that is a result of prematurely committing to beliefs that may not accurately reflect the phenomena in question (Chanowitz & Langer, 1980). When an individual operates from a state of mindlessness it likely leads to "mechanically employing cognitively and emotionally rigid, rule-based behaviours" (Fiol & O'Connor, 2003, p. 58), and involves overreliance and routine use of previously established categories (Butler & Gray, 2006, p. 215; Langer, 1992, p. 289). For example, attempting to increase short-term efficiency by mindlessly learning a routine often decreases the level of adaptability (Butler & Gray, 2006, p. 125) and can lead to overlearning – a condition characterised by "losing the ability to critically evaluate, explain, and adapt behaviour" (Langer, 1989, p. 20-21). Therefore, individuals who take on a single point of view and have one way of doing things can expect to encounter various complications or problems. For example, mindless acceptance of data or information brings about a belief of certainty that often cause committing to a solution prematurely (Langer & Piper, 1987).

By this definition of mindful and mindless action, rule-based automation such as RPA is inherently mindless because it mechanically executes a given set of rules and can not adapt in situations that are not defined in its rules. So, even though automation is mindless, the experts updating the rules of an automation software must be mindful when devising well-defined set of rules and algorithms for the automation software in order to arrive at correct, intended result that is to capture human expertise in automated systems (cf. Simon, 1991, p. 129). However, as Bargh and Chartrand (1999) note, human behaviour tends to follow most of the time nonconscious and automatic mental processes that are unintended and effortless. Thereby, as Levinthal and Rerup (2006, p. 504) point out, on the individual level it is required to remain attentive to one's context and capability to respond when unanticipated cues emerge in that context to sustain mindfulness.

To understand how mindfulness can be sustained on an organisational level, how mindless behaviour fits to this discussion, and how collective mindfulness emerges in organisational setting, research conducted about high-reliability organisations (HROs) (e.g., Weick et al., 1999; Carlo et al., 2012) provides insight into what is the significance of both mindful and mindless action and how those unravel in organisational settings. Even though the goal of this study is not to examine the characteristics of HROs per se, several similarities can be identified between HROs and non-HROs in how failures of foresight happen, how collective mindfulness can prevent failures, and in being attentive and understanding the consequences of even small failures (Weick et al., 1999). Non-HROs are in other words everyday organisations such as this study's case company. These everyday organisations share some HROs' characteristics, because long-term environmental conditions that consists of for example intensified competition, more demanding customer expectations, and shorter cycle time bring about harsh conditions where performance levels are set high and there is only small margin for errors (Weick et al., 1999, p. 50). These conditions can be expected to prevail, as environments in which organisations operate become more competitive, ambiguous, and complex (D'Aveni, 1994). Due to these conditions, organisations attempt to find ways to reduce slack in their operations for instance through resource constraints, by downsizing, through mergers, or with complex distributed computer technologies (Shin and Sung, 1995; Rochlin, 1997), which is why everyday organisations bear a resemblance to the "tightly coupled, interactively complex profile of many HROs" (Weick, 1990a). Therefore, to increase the reliability in organisations, one has to understand how mindlessness and mindfulness are induced in organisational setting that is described as collective mindfulness.

Weick et al. (1999, p. 51) describe collective mindfulness as "*a complex and rare mix of human alertness, experience, skill, deference, communication, negotiation, paradoxical action, boldness, and caution*". Based on the research about HROs, five key elements can be identified that contribute to collective mindfulness: (1) preoccupation with failure, (2) reluctance to simplify the interpretation of situations, (3) sensitivity to operations, (4) commitment to resilience to cope with surprising events, and (5) deference to expertise instead of relying on hierarchical structures (Weick & Sutcliffe, 2001; Weick et al., 1999, p. 8-9). As Butler and Gray (2006, p. 125) note, collective mindfulness is not merely the outcome of having individually mindful human agents in the organisation, because mindfulness involves the capacity to perceive essential contextual aspects and take opportune action on a timely basis. This means that mindfulness should be seen as a duality that comprises cognitive and behavioural aspects (Valorinta, 2009, p. 965). The cognitive dimension encompasses collecting relevant, meaningful information on the internal and external environment in a complex, distributed cognition system, making sense of the information to understand it, and remaining attentive to multiple perspectives of the situation and understanding it in the present context (Langer, 1997; Brown & Ryan, 2003). The behavioural aspect is about acting upon the information for example through routines that provide sources of pre-established action patterns (Levinthal & Rerup, 2006, p. 503-504). Similarly, Weick et al. (1999, p. 34) note that HROs attempt to achieve reliability "through processes of cognition as much as processes of production", which is why mindlessness coupled with thoughtless action is what causes the difficulties in coping with a constant flow of unexpected and non-routine events.

In this vein, Levinthal and Rerup (2006, p. 510) note that most studies in the context of collective mindfulness have failed to describe how mindful and mindless action complement each other by contemplating only the other dimension of collective mindfulness. Such view gives a simplistic understanding of the complementary interactions when mindfulness is associated with positive outcomes and mindlessness with negative outcomes (Levinthal & Rerup, 2006, p. 510). Carlo et al. (2012) expanded this notion of collective mindfulness and noted that the only possible way to attain that state is through a dialectic process of collective minding, meaning that different organisational agents demonstrate and cope with elements of mindful and mindless simultaneously. Collective minding emerges as these agents struggle with contradictions in the five elements of mindfulness as described by Weick and Sutcliffe (2001) and Weick et al. (1999, p. 8-9) and attempt to bridge the chasm between mindful and mindless action, which means that mindful behaviour can not be completely separated from mindless behaviour (Carlo et al., 2012, p. 1102). Hence, collective minding is “an unfolding process of becoming”, in which human and software agents continuously reconcile and balance with tensions of organisational contradictions. Moreover, collective minding is a totality which consists of interdependent elements that are intricately connected, out of which organisational mindfulness manifests itself at the system level. (Carlo et al., 2012, p. 1102)

Thus, understanding how states of mindful and mindless are reached on individual level and how mindless automation affects collective minding help to clarify in part how the information-intensive work carried out by human agents and algorithmic operations should be balanced to achieve reliable outcomes. In the following and final section of literature review epistemic and pragmatic action are examined to complement the discussion about human cognition and actions.

2.4 Epistemic and pragmatic action

Epistemic and pragmatic action were chosen as the fourth pair of attributes, because classifying a task to either one helps to assess whether a task serves informational, pragmatic, or even both purposes at the same time. Theory on epistemic and pragmatic action complements other central concepts in this study, and thereby it serves in part to form a holistic view of cognition and actions.

It is significant to understand both epistemic and pragmatic actions as essential parts of humans' activities and distinguish the roles of these actions as these actions have important roles in advancing a human agent towards a specific goal (Kirsh & Maglio, 1994; Kirsh, 2006). Pragmatic actions are performed to alter the world physically and bring an agent closer to a desirable goal in the external task environment, whereas epistemic actions are actions that have the primary function of improving an agent's cognition by modifying the external environment by uncovering information that is mentally hard to compute or cannot be detected at first (Kirsh & Maglio, 1994; Kirsh, 2006). As Kirsh and Maglio (1994) point out, epistemic actions have a key role in improving human cognition as those actions change and shape the inputs to an agent's information-processing system. Thus, this increases the agent's performance, because tasks that require cognitive actions and problem solving are not needed to be performed in the head alone. More precisely, epistemic actions simplify a task as the number of steps and memory required for mental computation are reduced, and the probability of mental computation error is decreased. (Kirsh & Maglio, 1994)

If human agents rely on their own memory or computational capabilities without utilising external supports, their performance is clearly worse as noted in a vast number of expert activities (Kirsh & Maglio, 1994). Therefore, as human agents make sense of the task environment with individual capabilities and tools in their disposal, the epistemic actions that an individual makes are performed to understand for example a calculation or a booking in financial accounting more comprehensively, which reduces the likelihood of an error and speeds up the process. It should be noted that all epistemic actions have personal payoffs and depend on interaction with the environment (Kirsh, 2006, p. 252).

Human agents can learn and make use of qualitatively different kinds of behavioural tricks, for example making external checks or verifications in order to reduce the uncertainty of judgments. These epistemic actions steer the agent to make use of the environment that helps to utilise of the person's limited cognitive capabilities in best possible way. (Kirsh & Maglio, 1994, p. 518) By performing simple environmental manipulations human agents can inventively shape tasks as the complexity profile of the task in question changes. Manipulating local conditions allows to maintain control and to meet the desired goals faster and more effectively. (Kirsh, 2006, p. 249-250) Although pragmatic actions are easier to spot and name, also epistemic actions can be identified everywhere. To name a few epistemic actions for example in a financial accounting environment, these could be writing down specific values from an AIS to a notebook for later use, sketching a T-account and listing account balances on debit or credit side, or as simple as setting a calendar reminder to remember to carry out a certain task at a specific point during the work day – anything that allows to make better use of a human agent's limited cognitive resources.

However, it is not always easy and clear how to draw the distinction between these two types of action. Certain pragmatic actions could also be seen to serve epistemic ends, and likewise epistemic actions could be viewed as pragmatic, when the external goal was in first place to advance epistemic ends. (Kirsh, 2006, p. 252) As Kirsh and Maglio (1994) note in their research, distinguishing whether an agent performs an action for epistemic rather than pragmatic reason is often hard to prove from a methodological point of view. This is because an action can simultaneously serve both epistemic and pragmatic purposes, which in turn makes it often difficult to measure epistemic and pragmatic functions' relative influence (Kirsh & Maglio, 1994). Thereby, as Kirsh (2006, p. 256-257) notes, it is essential to observe how people perform activities on a granular level to seek answers why human agents end up doing specific things out of several other possible actions to save cognitive effort. These actions can then be linked to cognition and analyses in order to get at distributed cognition's mechanisms (Kirsh, 2006). To conclude, human agents are closely coupled with the surrounding, local environment as we interact with different artefacts, technologies and other people to work around our cognitive limitations with the use of external tools and resources (Kirsh, 2006, p. 249-250).

3 Methodology

Before moving from literature review to empirical findings, research methodology and data collection methods are first discussed in this chapter to form an adequate picture about the nature and methods of this study, and how the methods and data collection techniques were used.

3.1 Research methodology

This study examines complex socio-technical phenomena and seeks to describe the characteristics of tasks in information-intensive work processes through different concepts and attributes. Moreover, the aim is to understand what the roles of human and software agents in contemporary information-intensive work processes are, and how do new technologies affect the ways how such work is organised.

As qualitative research focuses on examining and understanding how humans arrange themselves and their settings, and how these agents make sense of their environment in these settings through i.e. social structures and roles, symbols, and rituals (Berg & Lune, 2014, p. 8), thereby it is a straightforward decision to follow qualitative research methodology to answer this study's research questions. Furthermore, as Dougherty (2002) notes, it has appropriate methods to research and understand complex phenomena. The advantage of qualitative research is that it is possible to gain profound insight from phenomena where it might be difficult to obtain reliable quantitative data (Mäkelä, 2004, p. 20).

Methods used in the study are case study research method for providing essential qualitative research data, and the data is then analysed by using grounded theory method for inductive theory-building (Yin, 2014; Bryant & Charmaz, 2007). Employing case study research method allows retaining a holistic view by focusing on investigating a contemporary phenomenon in its real-world context, especially in the instance when boundaries between phenomenon and context are not clearly evident. (Yin, 2014, p. 2-4 & 10) Grounded theory method is then applied to investigate actualities in the real world and analyse the research data without having hypothesis in advance (Glaser & Strauss, 1967), and the method encourages for continuous interaction with the data and moving back and forth iteratively between the data and emerging analysis (Bryant & Charmaz, 2007, p. 1).

The data analysis in grounded theory starts off by coding the data by finding and conceptualising underlying issues, then producing concepts by finding commonalities between the codes, and moving on to forming categories based on grouping of concepts that share similar attributes (Allan, 2003, p. 2-4; Holton, 2007, p. 265-266). By investigating connections between the concepts and finding links between the categories it leads to the emergence of theory (Allen, 2003, p. 6). With this kind of inductive theory-building it is possible to move from detailed descriptions to more abstract concepts (Bryant & Charmaz, 2007, p. 15). The value of grounded theory method for human-computer interaction research lies in how to iterate skilfully between empirical data and analysis to form new theoretical understanding (Rogers, 2012, p. 61). Additionally, as Rogers (2012, p. 61) notes, the theory developed does not have to be completely new, but it can include a framework that presents a hierarchy of classes and sub-classes for a particular setting.

Although grounded theory method has been interpreted to mean that fieldwork should be carried out before literature review to avoid preconceived hypothesis, this is a misconception, as reviewing relevant literature review helps to have theoretical sensitivity, and form a basis for professional knowledge (Allan, 2003, p. 7; Strauss & Corbin, 1998; Bryant & Charmaz, p. 17). Therefore, literature review in this study introduces the frameworks and concepts of interest, and helps to generate understanding about the phenomena. Furthermore, as Bryant and Charmaz (2007, p. 20) point out, after developing the grounded theory a careful analysis of relevant literature can give cues how to raise its theoretical level and provide a sense how to discuss the topic.

Additionally, this study uses a form of methodological triangulation by utilising multiple sources of data from semi-structured interviews, direct observations, and documents to unveil diverse insights and uncover new information, which increase the study's quality by making the different data collection methods corroborate each other (Mäkelä, 2004, p. 12; Mason, 2002, p. 33). By combining different data collection methods in this way, it is possible to obtain a more comprehensive and richer view of reality and verify its many elements (Berg & Lune, 2014, p. 6). However, as Silverman (2014, p. 47) notes, ultimately the quality of data analysis is more vital than the quality of data to ensure the validity of the empirical study.

By following qualitative methodology and using these before mentioned research and data collection methods, it is possible to produce concepts and theories based on the answers and stories constructed by research participants who attempt to explain and interpret their own experiences (Corbin & Strauss, 2008, p. 10). Next, the data collection techniques are discussed in the following subsections.

3.2 Data collection methods

The two data collection techniques that were touched upon briefly as well as the preparation phase before the interviews and direct observation are discussed in more detail, to provide a thorough view of how the data collection proceeded.

3.2.1 Preparation

Before the interviews, the researcher had had several meetings with senior managers of the case company. During the meetings, there had been informal talks about how the financial administration shared service centre was formed, its current state, and where they would want to head technology-wise and what it required to do so. These meetings and informal talks helped the researcher to form a general picture of the organisation and its business function's situation. In addition, the researcher's professional background from financial administration helped to understand the work environment and tasks that the employees were performing in their work.

In order to collect data about the work in general and in specific about the tasks in information-intensive work processes, several interviews and observations were carried out in the case company. The case company's senior manager ultimately made the decision which employees participated in the interviews and observation, but the researcher requested that the participants would present all the main functions within the financial administration shared service centres (SSCs) in two locations, and have different age profiles, positions in the organisation, and educational backgrounds. All in all, backgrounds of the ones chosen to the interviews and direct observation by the senior manager were varied and overall most of them were experienced in different ways and had different skill sets to deal with their work, which was a proper starting point to collect data about the interview's topics.

A draft of the interview questions for both specialists and managers were written and it took several iterations to hone the questions under different topics to their final form as in Appendix B and C so that they would be understandable for the interviewees, and that the order of different topics would support one another. The questions for specialists in

Appendix B concentrated more on the information-intensive work and specific actions taken in the work tasks, whereas questions for managers in Appendix C focused more on company culture and the capabilities to take new automation tools in use. Both sets of interview question shared the questions about RPA in general and how the interviewees perceive it.

Furthermore, an introduction email message (Appendix A) was sent to the participants of interviews and observation one to three days in advance before the interview, so that they would have time to think about their usual work routines beforehand. The message also included two links to videos that introduced what RPA is in the hopes of sparking some thoughts and feelings about the software robots. This was done so that interviewees would already be oriented towards the interview topics and questions, so the need to brief them during the interview and observation situations would be as minimal as possible, which then allows to use the time allocated for one interview effectively.

Anticipating the expected attitude of the interviewees towards the interview topics and questions was hard, as participants from different backgrounds and work positions have most likely different attitudes towards the interview topics. Overall, the expected attitude toward work-related questions would be mostly positive, but the videos about RPA might have made them a bit sceptical towards the intention of the interview, or even reluctant to disclose all details about their work if they felt that their work was threatened by further automation. In addition, the researcher expected that most of the participants would already have some kind of idea what software robots are. Next, the interview process will be described in more detail, and how the interviews went overall.

3.2.2 Interviews

Semi-structured interviews were chosen as one of the methods to collect data, because it allows to cover different topics and areas of work during the span of the interview fluidly (Yin, 2014, p. 110-111). All interviews were held in Finnish, because all the participants and the interviewer speak it as native language. This made it easier for interviewees to answer the questions and describe their experiences in more detail than in English. Having interviews in Finnish meant also that translating different meanings from Finnish to English had to be done with care later on when transcribing the answers, as it requires one to be cautious not to change the meaning of a word, sentence, or even the tone of the answer to capture the correct meaning of the answer. Before starting an interview, every interviewee was told that the answers are anonymised, and also asked if he or she approves that the interview is recorded so that collecting and analysing the answers would be easier for the researcher, following the guidelines that Yin (2014, p. 77-79, 110) has outlined for protecting the human subjects participating to the interviews.

Altogether thirteen interviews were carried out: nine specialists from O2C, P2P, R2R, and debt collection functions, one team lead, and three senior managers. The three senior managers had different responsibilities within the company and business unit. In addition, one user observation of P2P specialist was carried out to complement the data collected from interviews, and results of the observation will be discussed in the next subsection. Table 1 lists all the participants and their work-related background in more detail:

Table 1: Data collection methods and participants' background infromation

Method	Pseudonym	Lenght (min)	Main work position(s)	Additional work responsibilities	Age	Experience in financial administration	Education	Years with the company
Specialist interviews	Specialist Susan	82	R2R	Key user, development projects, accounts payable, and account receivable	42	10 years: includes billing, P2P, O2C, R2R, financial statements, and tax returns	Vocational Qualification in Business and Administration	2,5
	Specialist Elizabeth	75	R2R	Fixed assets	63	About 30 years: R2R and budgeting	Vocational Qualification in Business and Administration	2,5
	Senior specialist Jane	75	Senior specialist in AIS development	Group accounting	56	24 years: financial manager, financial controller	Bachelor of Business Administration	2
	Specialist Emily	68	O2C		32	Several years: payroll clerk, transactions handling, billing	Bachelor of Business Administration	1
	Specialist Margaret	67	R2R	O2C	56	36 years: R2R, accounts payable, and billing	Vocational Qualification in Business and Administration	1
	Specialist Jenny	69	Debt collection		35	Several years: accounts payable and receivable, debt collection	Vocational Qualification in Business and Administration, further qualification in business law	1
	Specialist Helen	62	P2P and O2C		45	Several years: accounts payable and receivable	Student in Business Administration	2,5
	Specialist Sarah	72	R2R, P2P and O2C	Key user, and development projects	29	4,5 years: R2R, accounts payable and receivable.	Bachelor of Business Administration	2,5
	Specialist Christine	87	R2R	Fixed assets	51	About 30 years: Accounts payable and receivable, billing, and assisting in accounting	Vocational Qualification in Business and Administration	2,5
Manager interviews	Team lead John	70	Team lead	Development projects	48	Several years: shared service centre manager, project manager	Bachelor of Business Administration	1
	Director Lisa	85	Director	Sales, solution design, and concepts	52	28 years: Financial manager, and senior vice president	Master of Science in Economics	4,5
	Vice president Robert	55	Vice president	Sales, and solution design	60	27 years: Business controller, Group controller, and senior vice president	Master of Science in Economics	4,5
	Manager Mary	56	Manager of shared service center and service delivery		50	25 years: Financial manager, and software development manager	Master of Science in Economics	3
Observation	Specialist Amy	84	P2P		23	Couple of years: accounts payable	Master's degree student (Economics)	1

As the interviews were semi-structured, it was important to adjust to the flow of interview and present questions that fit the current discussion about a certain topic during the interview. As Yin (2014, p. 110) notes, at first the list of questions is pursued to be followed in a consistent, almost rigid manner, the actual interview situation oftentimes requires fluidity and adaptability. Understanding interviewee's reaction to particular questions and not cutting off a discussion that is not answering straight to a certain question was important, because that way it is possible to open new avenues of discussion to uncover unanticipated information. Overall, every participant had a positive attitude towards the interview situation and questions, and they were willing to share even very detailed information, which made it easy to discuss about the different topics during the interview.

During the last specialist interviews, it became apparent that the answers about P2P, O2C, and R2R work tasks were similar and started to repeat themselves, hence reaching full data saturation (cf. Silverman, 2014, p. 69) of what could be achieved with the study's questionnaire regarding specialist work tasks. Moreover, the interviews with managers provided insight in the organisations' culture, and helped to form a more thorough understanding of the context in which the specialists as well as managers perform their tasks and make decisions. Seven out of eleven interviews were held within a week, and the rest four interviews during the week after the first interview week. After finishing interviews at the two office locations, all the interviews were then fully transcribed based on the recordings. Even though transcribing thirteen interviews from Finnish to English was time-consuming as it took several days to finish the process, the transcriptions made it easier to analyse the interviews and saved time in the analysis phase. Going through the interviews and later analysing them gave also a sense of what sort of things should be attended to and paid attention to when performing the direct user observation.

3.2.3 Direct observation

The direct observation was carried out three weeks after the last interview to complement the interview data, and to gain more detailed understanding of a common financial administration process and its several tasks and actions taken to complete a certain task. Purchase-to-payment (P2P) process (as in Table 2, p. 52) was chosen to be observed while a specialist carried out different tasks involved in P2P process in a best-of-breed P2P accounting information system. This process was selected as the observable financial administration process, because it is known to include tasks that are mainly manual and routine, but also ones that require human judgment. Therefore, P2P process provides an interesting possibility to observe how a specialist carries out various tasks involved in the process, which provides valuable data to analyse the characteristics of certain tasks in the P2P process.

Due to time constraints, only one user observation was carried out. The data gathered from the observation was rich, as it gave plenty of insight to the actions taken to complete tasks in the P2P process. Additionally, it helped the researcher to observe the real-world environment in which the specialist – and the other specialists for that matter – worked in (Yin, 2014, p. 106). In hindsight, it would have most likely been beneficial to carry out at least a second user observation, because as Kirsh (2006, p. 256) points out, it is necessary to observe how people perform actions in detail and connect the actions to cognition and computational analyses to get at distributed cognition's mechanisms. Moreover, direct observation gives insight into how the specialist saves cognitive effort by doing certain actions, and into the ways the specialist uses resources in the surrounding environment that makes problematic situations easier (Kirsh, 2006, p. 258).

During the user observation, actions taken by the specialist were documented by writing down i.e. which windows the specialist opened, what data was inserted manually to fields in the invoice view, which other systems other than the P2P system had to be accessed and used to complete a task, what other cognitive devices such as paper notepad were used, and if there were interruptions in midst of performing a task. It would have required video recording to document the length of every window view, as in almost every situation the specialist moved from window to window and performed actions within a window swiftly. As video recording was not possible, time spent in a certain window could not be documented, but as mentioned, every action taken was documented in detail by writing it down. Moreover, the researcher presented a couple of questions to the specialist during the user observation to clarify the meaning of certain action and reasons to perform it. Although the researcher made minimal interruptions during the span of the observation, as Yin (2014, p. 106) points out, it should be noted that the specialist might have proceeded differently with the process and tasks, because the person was observed. However, the process and tasks seemed to flow naturally, and the observant did not seem to be bothered by the researcher's presence, so the data collection can be held reliable and accurate. With the use of methods explained and justified, findings from the interviews and direct observation are discussed in the next section.

4 Empirical study

In this section, the case study company and the business unit in which the interviews and direct observation were carried out are first introduced. After that the study moves on to introduce the overall findings that emerged from analysing the interview and direct observation data.

Moreover, the results of what kind of characteristics specific financial administration tasks possess are listed in discussion section of this study. The classification of tasks, activities, and processes follows APQC's (2017) Process Classification Framework, where tasks and activities are arranged under their respective process. Findings related to the characteristics of work tasks and their implications are examined in the discussion section.

4.1 Case Company X

The case company has several different business units and competence areas, and its offering consists of various analytics, business intelligence, IT-, and outsourcing services. The case company operates mainly in the Nordics and it has several offices in the region. This case study will examine one of the case company X's business units. This business unit in question is a shared service centre (SSC) serving external customers, and it has altogether around 60 employees out of which 48 employees are in service production. The business unit offers financial process services consisting of business process-as-a-service (BPaaS), software-as-a-service (SaaS) and IT services solutions.

When an external client outsources its financial processes and applications to be run by the business unit, the processes are converted to its shared services platform that uses modern, automated tools and applications such as Microsoft Dynamics AX, Exflow AX, and Palette as well as an invoicing legacy system. This way the external client's financial management processes and applications are kept up-to-date and managed accordingly, which helps the client to focus on its core business. Furthermore, the business unit takes the responsibility of maintaining and developing background IT services in their reliable, scalable, and data-secure IT environment. Moreover, one of the senior managers summarised the client promise and how companies would benefit from outsourcing their financial services to be run by the case company X's business unit during the interview:

> *"And our promise [to clients] is that by being on the journey with us you have a finger on the pulse, because our business is to run this [the processes and technology*

> *involved]. -- Isn't it true, that we get paid for having the latest stuff and knowledge about these, but also about processes, ways of working, robotics, artificial intelligence, and everything. So basically about it, what an ordinary company couldn't in any way invest in because there is no money."*

To improve the operations in their financial administration SSC, the managers of case company X's business unit are currently in the process of implementing RPA to their financial administration work tasks, and in addition considering adding ML as part of their automation tools in the future. After a couple of months when the interviews and observation had taken place, they have arranged workshops, in which the financial administration specialists have partaken the design process by pointing out possible RPA candidate processes and tasks, which is what the shared service centre manager Mary mentioned in the interview about involving the specialists to the design process:

> *"-- I know the processes quite well what those are, almost every press of button, but even still, the one who does it every day, that is where the best insight comes from after all."*

Taking these described circumstances and factors into consideration, case company X's business unit provides an ideal and interesting case to be studied, as it offers a view to an organisation's financial administration function, thus providing a real-world context for the information-intensive processes and tasks carried out in the SSCs. Furthermore, especially the business unit's managers in charge of running the SSCs put an emphasis on developing their processes with new technology applicable for financial administration work. To support this development towards higher level of technology utilisation in work processes, they already have an accurate profile of an ideal specialist to develop automation in their information-intensive processes:

> *Director Lisa: "Well probably an ideal who I would want to hire to our service center would be persons, who of course understand accounting law, latest interpretations from Finnish Tax Authority, and value added tax. But in addition, they would also have insight and enthusiasm to develop automation, and hopefully also experience. And specifically the role could be a bit different, not so much just a transaction crusher, but someone who could probably maintain and possibly even write those... clarify those business rules to these automation tools. Not so much relying on arbitrary memory, but could code that good insight and experience as a*

> *part of the business rules in our applications. So, in my opinion, that kind of experts would be needed in the future."*

These key users would be trained to use new automation tools and would then carry out development work related to the financial administration processes and systems. In financial administration, the processes and tasks carried out by specialists consists of manual, routine work where certain step-by-step instructions are followed relying on arbitrary memory as mentioned in the previous quote, but also of tasks that require human judgment. These are ideal activities to be analysed on task-level if software automation tools such as RPA or ML are suitable to the activities, and can the automation tools be used to augment or substitute human labour in particular tasks.

4.2 Findings

In the following sub-sections, the empirical findings from interview and direct observation data related to the topics introduced in the literature review section are next examined. In addition, other findings outside of the literature review topics and their relevance to this study are briefly examined. Even though certain quotes are placed under a specific topic, it should be noted that most of them have either a strong or a weak connection to other topics as well. Due to the interconnectedness of these topics and findings, in the upcoming discussion section these findings are reviewed and bridged together.

4.2.1 Information-intensive work

Next, an overall view of the work performed by the specialist in both SSCs and how the specialists think of their work are described. By analysing these, it is possible to form a general understanding of the work and its nature that is currently carried out in the SSCs, which helps to ground the other topics to this context.

In contemporary financial administration work, the different processes still involve plenty of manual work that take up plenty of specialists' work time. As a R2R specialist pointed out in an interview, checking and processing purchase invoices takes the largest part of the specialist's time during a month:

> *Specialist Susan: "Well, out of the working hours – if you think of these [the list of tasks, Appendix D] – largest part of time goes with purchase invoices. But I am part*

> *of the accounting team, so those are my responsibilities, and also to discover development areas."*

Although the specialist is in a R2R team and is responsible for the accounting and reporting of several companies, and even participates to development projects related to the financial administration processes and systems, the specialist uses most of the work hours during a month to process purchase invoices. The reasons why these invoices were not processed automatically by software vary from client's supplier forgetting to fill out a reference number to receiving invoices to email during monthly closings so that there is no time to send it to electronic invoice scanning service, for example. Hence, a skilled specialist has to dedicate time just to process invoices, which is time away from other activities such as development projects.

Although in the previous example the need for manual involvement was caused for example by deficiencies in data or urgency to insert data to a system, manual work is also carried out because of low-level of automation. Even though the data is imported from a database to an AIS, the system itself does not automatically process or verify the imported data. The following insightful, detailed description by a debt collection specialist sheds light to the task 5.3's manual process of choosing which customers' balances should be transferred to be handled by a debt collection agency:

> *Specialist Jenny: "-- in debt collection assignments [task 5.3] we do more manual work, when a debt collection assignment material importing is done… -- We take these papers in front of ourselves, we indeed print those in front of us. We also see in [the invoicing legacy system] a certain box, where everything is imported. That handling box. But, from the paper we have to look with a ruler for example on own electricity network area if there is in the end of a contract number for instance a letter L, and if that is part of the network maintenance contracts you don't export those to debt collection agency, as an example. And then the client company has set certain total balance values, that small, under 15 euros total balances aren't exported – those are passed to next invoice, or removed if the contract has expired. These are handled one-by-one in the material. -- Well, the [material] importing is done on 11th day and the transferral day is not until the 16th. -- The material can be, let's say 95 A4-pages, which we of course have as two-sided, so the handled amounts are large. -- …before the export [to debt collection agency] you have to check the*

> *material from the computer, if the customers have paid in between [11th and 16th], and then values totalling zero are removed from there."*

This quote highlights well the need for high attentiveness to carry out the task in question so that there would not be errors, because mistakes especially in debt collection are highly sensitive matter for customers as well as to the client company. What is also noteworthy is that a large part of this debt collection task is done by the human specialist manually on paper even though the data is available in digital format. A human specialist has to maintain a high level of attentiveness in this kind of manual data handling, which is a good example of a task where automation software such as RPA excels, because the computer can process large amount of data rapidly following the set of rules precisely. In addition, it is not enough for the specialist to check the balances in the material for one time, but the balances need to be updated and verified another time, so that there would not be unnecessary debt collection assignments.

In a similar vein, an O2C specialist pointed out that even though almost all of the received data is in electronic format, it is easier to go through the data when it is on paper. The paper in this instance works as a cognitive artefact, helping the specialist to have the data in a more manageable form:

> *Researcher: "What about if you think of the material, how much of it is in paper format, and how much of it is in electronic format? Do you receive paper material at all?"*
>
> *Specialist Emily: "No... the notifications come pretty much via email, that 'hey, can you enter this data'. Well, of course I print it for myself, so that it is easier to look it through with a ruler if there are many lines in it that everything is okay."*

As this and the following comment well reveal, much of the work carried out by the specialists in financial administration is rule-based, and in most cases, there is no room to interpret the given instructions:

> *Researcher: "Where does that information come from that you have to put it as minus [value on a sales invoice]?"*
>
> *Specialist Emily: "It came from the client company at one time, that in the future change the price always as minus, and now it is in my instructions folder. I do the invoicing as instructed."*

These previous quotes well underline the fact that much of the manual, repetitive tasks are based on a set of rules to be followed punctually, requiring a firm focus to the task at hand.

Even though the tasks are mostly rule-based, there is certain flexibility in choosing the order to carry out the tasks when those best fit to a specialist's daily schedule. However, some tasks are time-sensitive and must be finished before another task or process can begin. As the O2C specialist comments, dependencies between different processes need to be taken in account:

> *Researcher: "Do you think it is important that you have certain flexibility in your work, that you can do certain things first and then other ones? Of course, you have to have an order when you do certain tasks, but in the sense that you can decide."*
> *Specialist Emily: "Well, of course for example my payment matching [task 4.6] affects also debt collection. So, I need to have the unmatched payments entered to the system as soon as possible in order for debt collection to start their debt collection process. In that sense, I have to do payment matching first. Then you can do sales invoicing later during the day."*

Due to time-sensitivity, delays in some process which might cause additional delays in other processes and thus form a bottleneck. As the SSC manager mentioned in the interview, also AIS crashes and system downtime cause delays in various processes that also have effect on specialists' work schedule and workload:

> *Manager Mary: "If you have hundreds of thousands… I mean if you have 20 000 invoices cycling through in a month, so… and you have… if you think how many work days there are in a month, so it is quite a mass that you have to get through, and if something happens in one day that the process doesn't work, and it just cumulates and cumulates."*
> *Researcher: "Alright, so it was… did it happen, that the invoices were stuck [in the AIS]?"*
> *Manager Mary: "Yes, and you know what consequences it has. Invoices aren't paid, if those are stuck somewhere. It is part of the process, as the client is ordering something in the beginning, out of which purchase order forms, or in purchase-to-payment [P2P] ordering something that they need, and invoices are formed based on that, and then they need to pay those invoices. They [clients] are part of this in the both ends. --"*

As it became evident, the volume of electronic invoices in SSCs is significant, and even delay of one day can cause noticeable issues. Such problems with AISs can also cause invoices to go overdue, which might accumulate extra costs for the client.

As data flows from system to system, and when there are no deficiencies in the data, the AIS can make an automatic entry if such automation rule is coded to the system. However, manual handling of data is required in some cases, which calls for the specialist to concentrate that there are no typos and the data entered is correct:

> *Researcher: "You mentioned these different steps in AX and [the invoicing legacy system], do you manually insert data from system to another? What is manual work in those?"*
>
> *Specialist Emily: "-- transactions in accounts receivables are mainly automatic [task 4.5], except if reference information is incorrectly entered, and in that case, you have to enter it manually [task 4.6]. In sales invoicing AX-invoices are formed manually [task 4.8]. In [the invoicing legacy system] most of the data comes automatically [task 4.1], considerable majority actually. After certain batch processing data is imported to [the invoicing legacy system], but there are certain things in invoicing that you have to enter manually. One invoicing is actually an Excel-table, that has plenty of formulas all over in it and then you insert to a certain cell our data, and after that you take the place of use and insert it manually to [the invoicing legacy system] [task 4.3]. -- It is quite small text and you have to be accurate that you enter the right ones, and you have to check that do those [data] match. I have several times went all of those through again when there has been a typo."*

Same points as in the previous comment came up in several other interviews as well, the example of task 2.1 in R2R process was particularly insightful, as it tells what kind of typos or errors might happen during the manual processing of data which might cause difficulties in account reconciliation or reporting later if it is not noticed and corrected. In addition, it became apparent that even the specialists are thinking ways to automate certain tasks to reduce human errors:

> *Specialist Margaret: "-- there is plenty of information in the Excel, so you need to be careful in that way. Sometimes we thought how we could automate it, that the data sent by a client would be imported to the AX's journal receipt folder or booking folder in a form, that there wouldn't be a possibility to manually enter it incorrectly, as 331200 is way different than 332100, and it [the accounting entry] could change to completely something else [task 2.1]. --"*

As it can be concluded, processing purchase invoices or inserting data to AIS manually are just a few examples of repetitive, routine work carried out in SSCs as these quotes illustrate. These kinds of tasks could all be classified ignorantly just as tedious or toiling work, but as the following quote illustrates, the R2R specialist likes such manual work, but for a very specific reason:

> *Specialist Susan: "I have to say, that I wouldn't ever want to do copy-pasting [data from purchase invoices] full-time, it is like it that I can do a couple of purchase invoices [tasks 3.2 and 3.3]. In those, I just have to pick the prepared data, but in the manual journal receipts [task 2.1] where I collect the data I might do the calculation, and see the end result. That is the difference."*

During the interviews, other specialists made similar comments about their work that they would not want to just type values from one window to another mindlessly, although they would not mind doing such mindless typing occasionally. Instead, when they are untangling the data to an understandable form it gives them a sense of accomplishment as the end result forms in front of them, something that could not be achieved with just monitoring the work of automation software. Obviously, mindless typing can be relaxing for short time periods, which can help later on to put more focus on important tasks.

Next, findings about mindless and mindful action are examined, which complements the findings in this subsection, for example the relevance of slack in information-intensive processes, and performing tasks mindlessly or mindfully.

4.2.2 Mindless and mindful action

As it was discussed in literature review section, automation is mindless whereas human agents can act either in mindless or mindful way. Next, the focus is on examining how mindless and mindful action manifest in information-intensive work processes.

The findings continue with the same theme as in the previous quote, and as the R2R specialist's comment depicts, there is more in play than just mindless typing as the specialist has to mindfully assess what is important data and how do the pragmatic actions alter the overall financial state of a company:

> *Researcher: "Can you tell a bit more, what you meant with it that you enjoy manual work? I understand that you like the end result – seeing the result form."*
> *Specialist Susan: "Yes, I get the end result, but also it, that I have formed the documents and maybe even entered the data to there [AIS], so now I enter this one*

> *document here, then I take the next one, and now because of my documents the end result became like this. But if all the information is entered when I just press a button, and now that I press here 'book' – there came all the financial items – and 'book' – there came all the salary entries – the content hasn't opened to me yet. But I know that it is going this way, that the entries are becoming pre-formed more than before."*

As manual, routine tasks are being increasingly automated with new technologies such as RPA, it obviously transforms the way in which tasks and processes are carried out in information-intensive operations, and how specialists make sense and figure out the financial state of a given company.

Similarly, another R2R specialist pointed out the strengths of understanding various areas and detailed information in financial administration, through which operational awareness emerges:

> *Specialist Sarah: "-- in my opinion there is an advantage to it that you understand all of the general ledger and auxiliary accounting, as those are in connection in a way that some matter might… some difference forms on a purchase order, and then you often know what causes it. And when I take care of these companies' personal ledger accounts and also accounting, I might have myself made an error on a purchase order, and it is easier to find the data… or the error from there."*

Clearly, it is useful for the specialists to understand the context in detail, as they can then make connections between different financial figures more easily, which is valuable especially during monthly closings when there are only five weekdays to finish balancing the accounts and report the financial figures to clients. Therefore, understanding the context induces operational awareness and mindfulness.

Then again, the service center manager pointed out during the interview, that they have key users who are part of development projects, but the key users still do service delivery work to understand the tasks and processes they are developing:

> *Researcher: "About that, in what ways could the financial administration specialists be involved with the design of software robot use?"*
> *Manager Mary: "Well, we have in those processes… there have been so called key users even in these interviews, who have been part of the delivery organisation. They carry out each day… we want them to carry out each day some service delivery, so that they keep a grip with the tasks, but then they participate every time in these*

> *projects. Taking new clients or importing to new system… and developing the process, so in my opinion, that is already it, that processes are developed – that is their work.”*

This comment serves to highlight the notion that understanding the context helps the key users to understand the causalities of changes that might be considered to be applied to processes or systems. Thus, mindfulness emerges when specialists are willing and expertise-wise able to consider multiple views how to approach a task, a process, or a project.

Another example of mindful action was when during direct observation an O2C specialist wrote down an invoice number during the purchase invoice checking and reconciliation, because the specialist was mindful about the fact that there might be complications later on in balancing the ledgers due the changes made in a particular purchase invoice's balance. Although the specialist could not know at that moment if there would be an issue with balancing the ledgers, but because of familiarity with the process the specialist knew that the likelihood of facing a problem was high. Therefore, expertise and routine in handling the process induced mindfulness.

Another way to ensure that values are correct is to check those through additionally. The following quote illustrates the differences between the styles of working between different specialists:

> *Researcher: “But you haven't had problems in the sense… you haven't sent invoices which you haven't noticed to check for errors?”*
> *Specialist Susan: “I don't at least know that there would be. But it might also be, that I belong to that group of people, who check it additionally once more, that it surely was [correct].”*
> *Researcher: “Do you do like that often that you return to a previous accounting entry that you have made, that there might be some point needing to be corrected?”*
> *Specialist Susan: “Usually when I do it, I check it. I rarely return to anything, but if you think of it that how you do it… that if you wouldn't check it so precisely it might be faster. But my basis is usually, that I get it correct right way instead of returning to past one [an accounting entry], but maybe that affects the speed.”*

Other specialists might prioritise speed and efficiency, whereas in the previous quote the specialist prioritises reliability. Some mistakes in accounting that go by unnoticed on earlier stages in auxiliary accounting can cause problems on the client side as those might not be noticed in Group accounting:

> *Senior specialist Jane:"-- it is the worst situation, if something goes through all the way to client and we get feedback from the client that this isn't right. I don't check – when I do the Group [accounting] – so I don't check the auxiliary companies anymore that are those correct, only in the case, if I notice some significant error. But if we talk about millions and there is 10 000 [euros] error you can't possibly notice that with a bare eye.*

As this example illustrates, accountants doing auxiliary accounting need to be aware of the problems that might be caused later on if there are errors in the bookings or balances. Therefore, understanding the cumulative effect of errors, and staying attentive to the overall operational view is important in ensuring reliable outcomes.

Although having an overall understanding of operations would be important, some roles do not require a specialist to understand what goes on in other processes to carry out the assigned work assigned as the following quote describes:

> *Researcher: "Have you noticed, that if you made several small mistakes it would have led to a larger problematic situation, for example that there are wrong values on an invoice, and those are entered faulty to an AIS or some other systems?"*
> *Specialist Emily: "I don't know. I don't know anything about accounting. Most invoices are formed in [the invoicing legacy system] [task 4.8], and you don't have to choose account number as every product has pre-made accounting entries. -- But I don't know how it effects the accounting side, if I do an error in an AX-invoice, I don't know what happens."*
> *Researcher: "But does any situation come to your mind, where small mistakes would have happened – the kind of mistakes, which would have led to a larger problem?"*
> *Specialist Emily: "In fact... well, not a larger one, but in accounting they probably fix it with a journal receipt [task 2.1]. When I entered a wrong account number to a debt collection agency's reimbursement invoice [task 4.6] and noticed it myself when I reconciled the payments and accounts [task 4.7] in [the invoicing legacy system], that this doesn't match, so I just told the accountant that 'I messed up the account number, I'll put a new one coming for you'. Then it was in some way fixed with a journal receipt or something like that. -- That is a quite small thing, it is fixed and that's it, everybody makes mistakes."*

These kinds of minor mistakes as illustrated in the previous comment are common in financial administration work as human errors are bound to happen especially due time constraints and as attention level falls during the workday. In those circumstances, the specialist might lose a focused state and slip to perform the tasks mindlessly. Although in the previous quote, the mistake was only noticed later on when the accounts were needed to be reconciled and balanced, and was caused by overreliance on routines. This kind of mindless action could have been prevented, if the O2C specialist would have stayed attentive to the task, which raises the question if it is worthwhile for a human agent to maintain such high attentiveness level in these kinds of tasks.

Similarly, during another interview a R2R specialist mentioned that the attentiveness decreases as the day progresses, which is understandable as it is hard to maintain the same level of focus throughout the day. Moreover, the specialist mentioned the importance of slack in daily schedule as the possibility of an error decreases when there is time to do checking:

> *Specialist Margaret: "-- of course, there can be human errors, but the amount of errors decreases when there is time to be more attentive. When you have been figuring out numbers for nine to ten hours during the day, you get seriously a feeling, that you are tired of thinking if it really went right."*

Although specialists and the SSC manager recognise the importance of slack, it is hard to make time during monthly closings for double-checking for instance as the SSC manager's comment illustrates:

> *Manager Mary: "-- although we talk about automation and I talk about efficiency, but still the quality if number one. And it is very difficult to get people understand, that even though we have some… we had clocked an hour-to-hour schedule as we have monthly closings [tasks 2.4, 2.5 and 2.6] going on there [in the SSC], what happens at which moment, and there are deadlines when it needs to be ready. People aim for it, and then the quality suffers. And then on the other hand, if you are late, the client won't like it either, but we have tried to communicate, that check it even couple times [task 2.5]. It isn't so… our service level isn't reliant on seconds or even hours, that there is flexibility."*

Even though there is slight flexibility during monthly closing timetable, the specialists have to balance between efficiency and quality. With such mixed priorities, time constraints, and several long work days during monthly closings it is likely that reliability of operations suffers – in other words, the probability of errors is likely to increase.

Later during the interview, the SSC manager continued when asked if it would be likely that amount of errors would be reduced if specialists had more time for work tasks and time to double-check, the manager was certain that the work load takes its toll on attentiveness and hence on quality, too:

> *Manager Mary: "-- But it is just that, when the accountant deals with high pressure, so that is just the point, that when he or she can concentrate… it does load down, when you just type something. And when you type two days, and then you have two hours left to check the outcome. So, it does already load down so much, that you don't have the highest attentiveness level to check your two companies. If you can just continually look at the level of readiness, and someone else does the more manual control request, so that is way different starting point for the quality also."*

As noted before, errors that happen before monthly closings can be corrected when specialists work together or alone when an error is noticed. However, if errors happen during monthly closings and those go by unnoticed, it is likely to be noticed by the client especially if there is a notable difference in financial values on reports. Correcting faulty financial values takes additional time from the accountant and client-side, which also causes reputational damage depending on the scale of such error.

Therefore, errors in accounting entries cause additional clearing which takes time from other tasks. Especially during monthly closings when time is of the essence, such errors cause unnecessary interruptions, as all accounts need to be reconciled and in balance. Thus, in the context of financial administration, even small mistakes might cause delays in the already tight schedule during monthly closings, which might then take its toll on quality of work. As quality drops, it can be presumed that the client notices such change in the reports. In this case, client will most likely make remarks about the quality, which is never a desirable outcome for the SSC's specialists and managers.

These findings and notions about mindful and mindless action in information-intensive operations are linked to literature in the next section and discussed in more detail. Next, the findings about epistemic and pragmatic actions are examined.

4.2.3 Epistemic and pragmatic action

The research data provided insight into several tasks and actions taken to perform them. Especially direct observation data turned out to be essential, because in many cases epistemic actions such as scribbling down an account number on a paper might not be mentioned during an interview, as specialists might not regard those to be important part of a task. The following findings describe both epistemic and pragmatic actions that were performed by the specialists.

During the direct observation, a purchase invoice with unstructured data in the form a stamp in the invoice picture came up as in tasks 3.2 and 3.3. The stamp of a third-party vendor marked that the purchase invoice in question was part of an invoice factoring deal. As there had been a similar exception before, the P2P specialist knew to write down the invoice number and total sum to a paper notepad that could be compared to the data in the client company's ERP system via a remote connection. By performing an epistemic action of writing down certain data to a notepad, the specialist was able to find and write down the factoring invoice number to the notepad from the client's ERP system. Later on, it turned out to be a worthwhile move to write down the invoice number, because after importing and updating purchase invoice data to the client's ERP system as in task 3.6, the total balance of imported invoices didn't match to the total balance of general ledger in case company's P2P-system Palette. This meant that the specialist had to find what caused the difference between the total balances as in task 3.7, and by writing down the invoice number of the factoring invoice in question the specialist could easily find the cause of balance difference from client's ERP system as well as from Palette, as the factoring invoice values had caused similar differences before. Hence, this description well demonstrates the need for epistemic actions to carry out pragmatic actions efficiently, as the epistemic actions paid off in the end because those informed the specialist where to find the cause of balance differences much faster than without such information.

The direct observation provided another insightful finding; when a purchase invoice was missing a construction site reference number as in task 3.3, and the O2C specialist had to try to find the reference number so that the invoice could be processed. First, the specialist opened an Excel-sheet that contained construction site names, addresses, and reference numbers, and by using the find-command of Excel tried to find the correct construction site in question by typing an address found from the purchase invoice. As such address could not be found from the Excel-sheet, the specialist opened

Google Maps, and searched for the address that was written on the purchase invoice in order to find out if there were the client's active construction sites nearby the address in question. This way, the specialist tried to cope with the lack of information by creatively using Google Maps to find out if the purchase invoice could be allocated to a nearby construction site. Even though the search which took a bit over five minutes didn't help to find the correct construction site reference number, it showed that a specialist who has a deep understanding of a client's operations can perform creative, epistemic actions to find missing data.

A specialist might rely on other techniques as well, such as drawing a T-account on a paper to think about the unusual situation, and solve the exception. This comment from an interview illustrates well the epistemic actions taken by a R2R specialist that help to make sense of the situation and to process the calculation more reliably so that the pragmatic actions required to produce a result would be correct:

> *Specialist Sarah: "There are those kind of things, that if you have to think something absolutely new or unusual accounting entries [task 2.1], or similar things, I might draw a T-account and think how does this go before I start to make the accounting entry, but those are occasional and don't come up every month."*

By using pen and paper as cognitive devices, and following a simple accounting technique, it helped the R2R specialist to make sense of the financial data. Taking time to process the calculation and think about the situation informed the specialist to make a correct accounting entry. Thus, epistemic actions are natural ways of increasing reliability of operations because pragmatic actions have a higher probability of being correct. As it is oftentimes in financial administration processes, carrying out certain tasks serves pragmatic ends, but such actions also have epistemic value, as the tasks and actions performed also help human agents to form a more thorough, informed understanding of the different accounts of client companies.

All the quotes and examples have a same theme in common, as the situations described include an exception in a task. It might be missing data or errors on an invoice for example, but those all require problem solving which then calls for epistemic actions in order to make such information processing more manageable to end up reliably and efficiently to a correct outcome. In other words, in unusual, unpredictable, and non-routine situations epistemic actions are needed to be performed usually with the help of other cognitive aids, for example pen and paper, to carry out reliable pragmatic actions.

Although so far mostly only epistemic actions have been described, there is an abundance of work in financial administration, that require only pragmatic action to handle such tasks. As the R2R specialist points out in the following quote, the capability of automation to process data is limited when there are exceptions, which requires the specialist to handle the exception:

> *Researcher: "What is your role, when we think of human and technology, so what is the role of human in this three-way matching? Does something need to be still checked?*
> *Specialist Susan: "In real life it isn't always in the right place on the invoice or in that file."*
> *Researcher: "What is not?"*
> *Specialist Susan: "That purchase order number for example, and in that case my job is to spot it where it is written on the invoice and I put it in the system in the right box [task 3.3]. And after that I pick the right lines to it from behind of the order, sort of. --"*

This example perfectly sums up the source of most of the mundane and routine manual work, namely missing data, or data that is entered to wrong spot on a document. Especially tasks that require inserting data from one window to another are examples, where only pragmatic, mindless action is required.

When another R2R specialist was asked about what kind of manual work has to be done and if data has to be moved between AIS and another, the answer gave a good example about pragmatic action:

> *Specialist Christine: "-- quite a bit comes from the client, for example pdf purchase invoices [task 3.2], and that is copied. We have on our [computer] desktop separate import folders and I have one for purchase invoices, where I move the copied pdf. It then reads it… no wait it doesn't read it automatically, I have to go to Exflow where it says 'manual', I click the 'manual' and then it informs how many it is importing. If I have copied one pdf invoice to the import folder, it imports it and I have it then under review. Then I start to process it – I click it open in Exflow, and then I have the [invoice] picture open on the side [of the screen] and then I start to check invoice number, invoice date, and such, just like the robot [RPA] did on the video… reading it, I am like the robot."*

Even the specialist regarded the task as something that is carried out mindlessly step-by-step, just like a RPA tool would. Every action performed in the task takes the specialist closer to the completion of the task, in this case manual handling of a pdf purchase invoice. Therefore, this quote provides a good example about a task that requires merely pragmatic actions to complete. With findings about epistemic and pragmatic action examined, next distributed cognition and findings related to it are reviewed.

4.2.4 Distributed cognition

The findings reviewed in the previous subsections offer a detailed view about the specific cognitive processes, physical actions, and information-processing activities required to be performed in a complex, distributed cognition system. However, some of the findings gave additional insight into the concepts related to distributed cognition, and those are reviewed next.

When talking about distributed cognition, an important aspect is to understand the limitations of human agents' sense-making and automation tools' information-processing capabilities. Although it became clear during the interviews that most specialists were not familiar or even heard about RPA or software robots and how those work, and their first touch to RPA were the two videos in the introduction email, some interviews provided insightful comments about how to arrange work between a human agent and a software tool. A R2R specialist's comment about maintaining the software robot – or in other words, updating automation rules – captures well the essence of frame problem and bounded rationality:

> *Researcher: "If a software robot would take over certain tasks, for example accounts payable or accounting tasks, do you think it would be more difficult to maintain skills needed for the job?"*
>
> *Specialist Margaret: "Of course, if you don't physically or otherwise participate to a task like that, I believe that the skills get rusty. So that I always need to teach the robot the new information… instruct it in that way."*
>
> *Researcher: "You mentioned that skills get rusty, so in what ways those would get rusty… for what reasons? -- You wouldn't comprehend the process?"*
>
> *Specialist Margaret: "Yes, or you would need to maintain the robot continually, that I have the robot's information, or the robot has my information. That kind of*

> *connection, so that it doesn't go to the point that only the robot works here and… I want to be up-to-date."*

In order to software automation tool to work at all, a human agent needs to encode knowledge about tasks into coded form, which the software then follows. This sets the frame in which the software can operate, and the human agent can then expand it by encoding more knowledge for its use. The R2R specialist points out, that the interplay between human and computer needs to be arranged so that both sides can improve and expand their knowledge about the work, because not maintaining the other side would hamper the development of overall operations.

A debt collection specialist was also asked a question about maintaining skills used in the work if a software robot took over some of the manual tasks, and the answer was very similar to other answers, but in addition the need to keep oneself updated about the newest regulations and changes came up:

> *Specialist Jenny: "Well, yes. In some tasks. Especially in the long run when we in debt collection have new regulations and changes coming up annually, so you won't keep up with those – for example what declarations there are and others – so you lose touch with those quite fast. It kind of depends, what it [a software robot] would do. If it would be assigned to some nice typing job. That kind of what just takes time unnecessarily, but what has to be done."*

This comment, as well as the previous one, serve to highlight the fact that due to changes in regulations and laws, rules about how to perform certain tasks need to be updated and monitored.

As it was discussed in literature review section, the work performed in loosely coupled systems is highly context-dependent, contingent, and unpredictable. The following example illustrates well how some of the problems are at first poorly structured, and become well-structured only when the agents begin to carry out activities and learn more about the problem during problem-solving. In addition, the O2C specialist is left to decide what is the best course of action to take when the situation unravels:

> *Specialist Helen: "-- we had sorted out this terrible jumble of credit notes, that one pays another with a credit note, and the other pays the third one, because the third can't pay to client, if the others don't first give money to it. And then who addresses what kind of invoice for whom, and who pays to where, and how those are then signed off from the ledgers before… now that I had been forming sales credit notes*

> *for the two companies, so the same invoices would have popped up to the [sales credit note] material, if we wouldn't have signed off [invoices] in between."*

As this example illustrates, the specialist has to decide what artefacts should be used and in which order to untangle the dynamic situation. These kinds of exceptions that need resolving are recurring in financial administration, and require adaptation due changing situation and also awareness of the situation's overall picture in order to make appropriate decisions that take the specialist closer to the goal of solving it. In contrast to this, an example of tightly coupled system in financial administration context would be an automated software processing data mindlessly as the problems are made well-structured in advance, and the use of resources is fixed. In the case of software, if there is an exception that the software can not process with the well-structured rules, then such exception is handled by a human specialist like in the previous quote. With the findings reviewed, the next section will discuss and link findings with literature to bring about new insights about human-computer interaction in information-intensive work.

5 Discussion

With the findings outlined in the previous section, this section will discuss both the empirical findings and the reviewed literature, and link them together. The research question that this study answers is:

1) *How does the interplay between human and computer manifest itself in contemporary information-intensive work processes?*

By reviewing literature about distributed cognition, it was possible to establish an overall understanding how individuals and artefacts are related to each other, and how human agents offload their cognition into the environment, which is an essential starting point for this study and answering the research question. Distributed cognition describes how technology and socially created media of communication act based on and change representations, and thus, carry out computations or information processing activities (Perry, 2010, p. 389). Two concepts that are closely connected to distributed cognition are bounded rationality and frame problem, that describe the limitations of human's sense-making, and computers' capability to process data. Building on this, theory about mindful and mindless action was reviewed, which expanded the understanding how a human agent handles work tasks on an individual level, and what is required to reach collective minding on an organisational level (Butler and Gray, 2006; Carlo et al., 2012). In addition, literature about epistemic and pragmatic action was reviewed, which gave even more nuanced understanding about the nature of cognition and actions that are taken to reach the goal of a task (Kirsh and Maglio, 1994). Moreover, literature about information-intensive work, algorithmic operations and digital material involved were reviewed to illustrate that in most cases human specialists read representations of data such as pictures of invoices, whereas computers process either structured or unstructured data in the form of zeros and ones (Conceicão et al., 1998; Megill, 2012, p. 67).

These concepts from existing literature are next used to characterise the sample of common tasks in financial administration. The classification of tasks, activities, and processes follows APQC's (2017) Process Classification Framework, where tasks and activities are arranged under their respective process. Based on the findings in the previous section, the characteristics of specific work tasks are listed in Table 2:

Table 2: Mapping and characterisation of tasks in financial administration

Reference number	Task in financial administration	Human/Computer	Epistemic/Pragmatic	Value-added/Support	Mindless/Mindful	Rule-based/Human judgement	Recurring/One-off	Does the activity require special knowledge other than using different softwares? Y/N
1.0	**General tasks in financial administration**							
1.1	Set up a new supplier in AIS	H	P	S	ML	RB	R	N
1.2	Set and enforce approval limits	H	E	S	MF	HJ	R	Y
1.3	Validate conversion data	H	P	S	ML	RB	R	Y
2.0	**Tasks in R2R process**							
2.1	Add a journal receipt in AX based on data sent by client (ie. accruals)	H	P	S	ML	RB	R	N
2.2	Make fixed asset accounting entries in AX	H	P	S	ML	RB	O	Y
2.3	Activate fixed assets on project completion	H	E	S	ML	HJ	O	Y
2.4	Reconciliate accounts in AX	H	E	S	ML	RB	O	Y
2.5	Validate account balances in AX	H	P	S	MF	HJ	R	N
2.6	Form monthly financial reports in AX	H	P	S	ML	RB	R	N
2.7	Form specialised reports for clients	H	P	VA	ML	RB	O	N
2.8	Form financial statements in AX	H	P	S	ML	RB	R	N
2.9	Form tax return form in AX	H	P	S	ML	RB	R	N
3.0	**Tasks in P2P process**							
3.1	Match invoice, purchase order, and receiving report in AIS (three-way matching)	C	P	S	ML	RB	R	N
3.2	Process invoices and send those forward in AIS for client's approval	H	P	S	ML	RB	R	N
3.3	Resolve invoices with deficient details	H	P	S	ML	RB	R	N
3.4	Inquire missing invoice data	H	P	S	ML	RB	R	N
3.5	Pay out approved invoices	H	P	S	MF	RB	R	N
3.6	Upload purchase invoices to client's system	H	P	S	ML	RB	R	N
3.7	Reconciliate accounts' balance differences between own AIS and client's system	H	P	S	MF	RB	R	N

4.0	**Tasks in O2C process**							
4.1	Generate customer billing data	C	P	S	ML	RB	R	N
4.2	Inform about exceptions in billing data	C	E	S	ML	RB	R	N
4.3	Analyse and resolve exceptions in billing data	H	P	S	ML	RB	R	N
4.4	Transmit billing data to customers	C	P	S	ML	RB	R	N
4.5	Receive and match payments to sales invoices	C	P	S	ML	RB	R	N
4.6	Analyse and resolve payments with deficient details	H	P	S	ML	RB	R	N
4.7	Reconciliate payments' balances	H	P	S	MF	RB	R	N
4.8	Form an invoice in AIS based on data sent by client	H	P	S	ML	RB	R	N
5.0	**Tasks in debt collection process**							
5.1	Form a security deposit Word-document	H	P	S	ML	RB	O	N
5.2	Send customer's new sales contracts to affiliated parties in AIS	C	P	S	ML	RB	R	N
5.3	Correspond and manage delinquent accounts	H	P	S	ML	RB	R	N
5.4	Form a list of customers' contract termination	C	P	S	ML	RB	R	N
5.5	Inform a third party for termination of customer's contract	C	E	S	ML	RB	R	N
5.6	Determine ways to handle default accounts	H	P	VA	MF	HJ	R	Y
5.7	Process and register debt restructuring payments	H	P	S	ML	RB	R	Y

Building on the analysis of the above sample of tasks, the discussion turns to explain how the interplay manifests itself between human specialists and computers in information-intensive operations.

After careful analysis of research data and listing the most common tasks in financial administration, it was possible to identify and characterise many common information-intensive tasks and activities. The tasks are characterised based on the attributes introduced in the literature review. First of the attributes is whether the task is done by a human specialist or processed by computers. Secondly, it is examined if the task has epistemic value, or is it carried out in pragmatic manner. Third one is whether the task is in a support role or is it considered to be a value-adding task. Fourth characteristic examined if it is required to apply judgment in a mindful manner to complete the task, or is the task processed mindlessly. Furthermore, there were two additional attributes that were examined with each task, as those helped to further understand the nature of a task. First one examines whether the task is rule-based, or does it require applying human judgment, and the second one seeks to clarify whether the task is one-off which means that such task is done seldom, or is it recurring which implies that it is done almost every day.

The tasks listed in the table in Table 2 portray a wide variety of information-intensive work in financial administration sector, which should give a comprehensive view of the most common tasks carried out in such line of work. As one of this study's objectives is to examine financial administration's information-intensive work, the tasks listed in the table comprise the main processes and a broad array of tasks done within those processes. By assessing and profiling the tasks based on the set of characteristics as in Table 2, it gives a sound understanding of the characteristics of contemporary financial administration work. With such assessment it is possible to say whether new automation tools are fit for the tasks, and if further automation can augment or replace human labour required in a certain task. Furthermore, as tasks are profiled with certain characteristics, it is possible to describe the overall characteristics of R2R, P2P, or O2C processes, which in turn make it possible to say how potential candidate a given process is for further automation.

The sample of tasks characterised in Table 2 as being carried out currently by a human (H) agent in a pragmatic (P) way that is a support (S) task, involving only mindless (ML) action as those are rule-based (RB) tasks requiring no (N) other knowledge than knowing how to use the system are the most potential candidates to be automated such as tasks 1.1, 2.1, 3.2, 4.6 and 5.3. On the other hand, tasks that are ideal for human specialists to handle are characterised to require mindfully (MF) applying human judgment (HJ), for instance tasks 1.2, 2.5 and 5.6. Furthermore, tasks that are characterised as epistemic (E) are at the same time also pragmatic ones, as finishing such task takes one closer to the goal. However, tasks that are marked as epistemic provide essential information for a specialist, which is why those are considered as tasks that inform a specialist.

Even though epistemic actions decrease the chance of an error in a cognitive process, it does not exclude the need for acting mindfully. Epistemic actions help human agents to make sense of their environment better, hence automatic epistemic notifications from computer software help a human specialist to be aware and informed of issues in an automated process. The specialist needs to assess an issue mindfully, use expertise, and apply judgment to find a way to overcome an issue. Mindful behaviour is part of making more accurate pragmatic actions when updating the set of automation rules, as the specialist will take in account various perspectives when figuring out what is the best way to approach an issue. In this sense, mindful behaviour helps in part to overcome bounded rationality, as various perspectives are taken in account and if needed, other specialists are consulted for their expertise to bring about the best outcome as several specialists noted during the interviews. On the other hand, epistemic actions are taken to ease the cognitive load and inform the specialist to take correct actions (Kirsh and Maglio, 1994). When the automation rule-set is updated, the automation mindlessly follows it, and once again informs the human specialist about exceptions in which the automation tool could not process data with the given rule-set, which then requires human intervention and mindful judgment. These updates to the automation rules expand the set of rules, or in other words the frame in which the automation can operate and process data to complete tasks, thus alleviating the frame problem.

In Table 2, tasks such as 3.1, 4.1 and 4.5 that are already processed by a computer (C) included characteristics of pragmatic, mindless action and were rule-based, which supports the notion that tasks that include these three characteristics are the most ideal targets to be automated if such tasks are done by a human specialist. By examining the characteristic profiles of the tasks in the table, it becomes apparent that a large number of the tasks currently performed by human specialists would be ideal candidates to be automated as their characteristic profiles include H, P, S, ML, RB, R and N attributes, especially the ones falling under P2P and O2C processes.

However, in debt collection process, task 5.6 includes characteristics of VA, MF and HJ. In the task, situational awareness is needed, and the human specialist has to work in co-operation with other specialists from third-party companies. Therefore, the specialist needs to have a sense of overall situation and what is the best course of action to take. Furthermore, debt collection is a highly sensitive matter for both the customer and client company, and as it became apparent in this case's interview, the client company values highly good customer service, so the specialist has to acknowledge in each debt collection assignment what is the best way to approach the situation.

Understanding these characteristics of the listed tasks helps to understand how to improve them, the processes, and financial administration in general from a practical point of view with automation tools such as RPA or ML. Thus, when computers and humans focus on operating with their respective strengths, it means that software-based automation tools running on physical computer hardware can process data more reliably and faster than a human specialist could, as software processes data whereas a human would examine the representation of data, for example a picture of an invoice, as the theory of information-intensive operations and distributed cognition suggests. This means that the repetitive, predictable, and at least somewhat tedious information-intensive tasks can be automated to increase efficiency and reliability of operations. As more sophisticated software automation tools become more applicable for business needs, transactional and integrative manual work in information-intensive processes as in Figure 1 can be automated with computer software infused for example with RPA and ML.

Nevertheless, expert and collaborative work as illustrated in Figure 1 would still be required to be done by human specialists, as those require applying judgment mindfully, deep expertise, and finding alternative ways to approach a task compared to routinely carrying out a task. It becomes evident that the outcome of such change means that the work suitable for human specialists would be more complex, which requires mindful behaviour on an individual level to be able to assess the situation and apply judgment. It is also important to note that tasks and their outcomes or outputs that involve manual mindful effort are also more highly valued by the employing company as well as client companies as those provide value compared to the repetitive, predictable tasks done for supportive purposes.

However, automating all possible tasks that are automatable means that data and information will become increasingly aggregated. This in turn means that specialists would need to create an overall picture about the operations without fine-grained understanding about financial figures, and as Butler and Gray (2006, p. 221) point out, it makes maintaining collective mindfulness more difficult. As a R2R specialist noted in an interview, if one performs various tasks in different processes it creates a more thorough understanding of the system and financial figures at large, which helps to locate a possible error in bookings easier. For an organisation to realise the full potential of collective minding it needs to organise its operations in a way that it can create an environment in which properly situated and active cognition can be best utilised as it is ultimately the basis for reliable action (Butler and Gray, 2006, p. 214 & 221).

Even though usually in the field of financial administration and overall in information-intensive services automation is initially implemented into processes to seek to improve efficiency and reduce costs, paradoxically higher automation level can also be seen to enhance reliability of such operations. In other words, automation decreases the amount of human errors in processes and tasks, but errors can also be prevented as automation frees time for human specialists to concentrate on their unique areas of strength of sense-making and collaboration. For example, during monthly closings and reporting, time is limited to carry out all the required tasks, and the specialists are on a tight schedule to finish in a given time frame. As automation processes routine, predictable tasks, it allows human specialists to put more time in checking and possibly reconciling account balances and bookings, increasing the reliability of operations and validity of outcomes as human errors are decreased and there is more slack in the processes to verify financial figures. As a result, routine-based reliability as described in this paragraph can only take one so far in terms of increasing reliability of outcomes and providing slack to proactively seek unexpected situations, and responding to them, because such approach begins to deteriorate specialists' skills. Deskilling thus hampers collective mindfulness, and therefore seeking reliability through the dialectic process of collective minding would be a better choice to arrange information-intensive work processes. This means that organisations would need to strike a balance between efficiency and reliability.

Therefore, even though a large share of information-intensive tasks at least in financial administration can be automated, the human cognition and sense-making is needed to understand novel situations in information-intensive work and also to apply the attained knowledge to overcome the limitations of automation. Drawing from the prior research and literature about this topic, and from the findings based on interview, direct observation data, and what is discussed in this section, a framework as in Figure 2 can be formed:

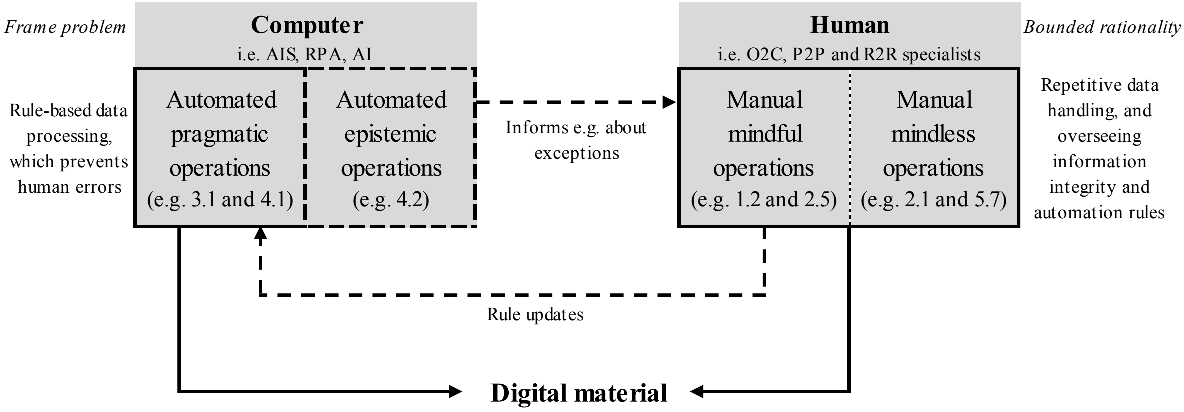

Figure 2. Loosely-coupled distributed cognition system in contemporary information-intensive operations

The framework in portrays a complex, loosely-coupled distributed cognition system, in which computers and human agents perform information-intensive operations by carrying out automated or manual, epistemic and pragmatic as well as mindful and mindless actions, both hindered by their respective limitations – frame problem or bounded rationality. The actions performed in the complex system either directly or indirectly contribute to a more reliable and efficient creation of digital material when operations are arranged as in Figure 2. The framework visualises the interplay between human and computer, and it combines the earlier concepts and this study's empirical findings discussed within the same framework.

The framework indicates that the automated pragmatic operations mindlessly process digital material in binary format to generate new digital material – in this case for example accounting data and bookings. The human manual operations that are both mindful and mindless also create digital material by interpreting the data and symbols visually, and based on the available data and attained expertise choose the best course of action to process the digital material. However, the mindful side also updates the rules and set of instructions which the automated pragmatic operations follow. Human experts can thus create instructions for automated operations to notify them for instance about missing values on a purchase invoice which the automation could not therefore process. These notifying mechanisms are titled as automated epistemic operations in the framework, which inform the human expert about exceptions, thus alleviating the bounded rationality and expanding the cognitive limitations of a human expert. In turn, the human expert can expand the frame in which automated pragmatic operations work by programming new instructions, thus making the overall complex, loosely-coupled distributed cognition system slightly more robust and reliable.

This study's results serve to highlight the notion that even though automation excels in data processing, it is ultimately only as good and reliable as its set of instructions are, which is why one needs to be mindful about the ramifications of implementing automation to work processes. The framework thus marks the importance of understanding the coupling between automated algorithmic operations and human mindful and mindless action in information-intensive work processes to achieve efficient, but reliable performance.

6 Conclusions

This section summarises the main findings, and gives recommendations and discusses managerial implications. Furthermore, limitations of this study are discussed, and suggestions for further research are given based on the findings and observations discussed in the previous chapter.

6.1 Main findings

The aim of this study was to examine how does the interplay between humans and computers manifests in the contemporary information-intensive work on a more detailed level. This was achieved by first reviewing literature about the topics of information-intensive work, distributed cognition, mindful and mindless action, and epistemic and pragmatic action. With this literature it was possible to establish an understanding of different contributing factors and limitations to human cognition, what are the ways how humans make sense of information, and how do computers process data compared to human agents.

Then by examining the rich empirical data collected from interviews and observation of financial administration specialists, it allowed to code the data and categorise it under the four beforementioned topics. With the data coded, it was possible to characterise the most general information-intensive financial administration tasks under specific work processes, which also offers a more structured and nuanced understanding of the tasks and work processes in this field of work. Linking the empirical data and existing theoretical literature together allowed to arrive at Figure 2, which illustrates a complex, loosely-coupled distributed cognition system. It makes the different elements and contributing or limiting factors that affect the distributed cognition system apparent on a general level.

In the framework, human agents contribute to the system through both mindful and mindless actions. Through mindful action, the aim should be to improve the automation rule-set gradually by mindfully assessing how exceptions should be solved and finding ways to utilise the expertise of other human agents as one human agent can only know so much due to bounded rationality. Mindful action also aims to contribute in part to the creation of reliable digital material, for example by checking for faulty values in bookings in an AIS. On the other hand, mindless, pragmatic action carried out by human agents seeks to create digital material for example by typing specific values to an invoice or inserting an account number for a booking. However, it is human to err, and for example after several hours of work concentration level may decrease which causes the human agent to slip into mindless state. In such state human agent is not always alert enough to notice and correct mistakes. Therefore, some mistakes can go by unnoticed which may cause different kinds of problems especially if a customer or a regulator such as tax authority notices the error.

Thus, the computer-side in the Figure 2 should be the main contributor in processing data and generating digital material as once those are given correct rules which to execute automatically, there are no errors in the digital material – in this case for example in invoices or accounting bookings. However, the frame problem restricts the extent of what computers can process and generate based on the data, as those can only follow rules or act upon available digital material that the human agent has provided. Therefore, if a properly working feedback loop can be established between human mindful operations and automated epistemic operations, the both sides of the system mutually help a bit by bit to alleviate their respective limitations – bounded rationality or frame problem – thus improving the quality and reliability of digital material gradually.

Based on these findings and the framework in Figure 2, it can be concluded that the strengths of human agents over computers are especially their capability for applying judgment mindfully and utilising deep expertise through collaboration to assess the implications of actions in the grand scheme of things. Thereby, expert and collaborative work as illustrated in Figure 1 are the areas of strength which are also difficult to automate. Even still, such work could and should be amplified with new technologies to generate better insight to be used by the human agents which could lead to improved outcomes if both the positive and negative effects of automation on human cognition and sense-making are considered mindfully. Computer or automation software is inherently mindless and can only act upon the given set of rules, but on the other hand computers can process data significantly faster and with lower rates of errors which makes them superior in routine, repetitive information-intensive work compared to a human agent who interpret data visually and handle it manually. This means that computers should especially carry out large part of tasks that fall in the categories of routine and integrative work as in Figure 1.

All in all, by compiling several lines of research, this study sought to provide novel insight into the complex and intricate ways how the interplay between humans and computers manifests in contemporary information-intensive work. As no similar research has been made to the knowledge of the researcher, this study provides novel theoretical contribution and actionable insight for managerial purposes.

6.2 Recommendations and managerial implications

The managerial implications are manifold in this study. First of all, the task listing as in Table 2 provides a detailed understanding of the financial administration tasks and processes. Although understanding the different concepts presented in this study is of the essence to grasp the whole value of the task listing, by familiarizing oneself with these topics will provide a better understanding of information-intensive work, that helps in part in coordinating activities and organising for efficient, reliable operations.

Secondly, mindless action as illustrated in Figure 2 will always be part of the financial administration work. An example of such mindless, pragmatic work is handling exceptions which is caused by missing values on an invoice. However, new technologies such as RPA and ML will decrease the amount of this kind of mindless, pragmatic information-intensive work because such technologies can perform the same tasks more rapidly, accurately, and with lower costs. As the routine and integrative work reduces, it will drive the focus of information-intensive work where humans excel towards expert and collaborative work as illustrated in Figure 1.

This transition toward expert and collaborative work calls for managers to steer human specialists' ways of working, thinking, and overall mindset to a more mindful direction – one, that recognises the causalities of actions in the complex, loosely-coupled distributed cognition system at large. Therefore, practitioners should take a proactive stance in educating their current employees to understand what this transition means to them on an individual level, upskilling them to meet the demands of future work, and considering what kind of talent is required in future to thrive in information-intensive operations.

Although it is only possible to make educated guesses what the speed of this transition is going to be, what is certain is that the information-intensive work content – tasks, tools, interactions, and cognising – are transforming as new and emerging technologies applicable for business needs are implemented in use. These new technologies suitable for information-intensive operations today are RPA, ML, and AI. Although the findings of this study support the notion of increasing the level of automation in information-intensive work processes to improve reliability and quality of operations, rather than just seeking a plain technological fix, practitioners need to consider the both the positive and negative implications of further automation.

Any information-intensive organisation that wants to utilise the full potential of the new technologies such as RPA or ML needs to also consider how automation impacts specialists' sense-making capabilities, does it help to situate cognition better, and whether it positively affects collective minding. Thereby, managers who mindfully assess how changes such as introduction of new automation technology affects specialists, organisation, and the distributed cognition system in general can prevent larger operational issues emerging in the future.

6.3 Limitations

As this study is qualitative in its nature, this research's reliability can be assessed through the criteria of reliability, validity, and generalisability (Eriksson & Kovalainen, 2008, p. 291). This study's reliability is sought to be proven by describing clearly how the study is conducted – what literature is used, what methods were used to collect empirical data, and overall to present the consistency of research throughout the study. The main data collection method in this study were semi-structured interviews, as altogether eleven interviews and one user observation were carried out to collect empirical data which provided rich data for the study. Even so, the data was collected only from one organisation that operates in the field of financial administration. Therefore, it is possible that the results might differ if the data would have been collected from another information-intensive work industry and organisation.

Furthermore, additional user observations might have revealed novel, more detailed information about the information-intensive financial administration work tasks that were in the focus in this study, which might have affected to some extent the task characterisation. Although the researcher attempted to remain objective while conducting the user observation, it should be noted that observation situations are always experienced subjectively and selectively (Anttila, 2000, p. 221), which means that the observer's expectations and focus on specific things over others might have affected the results of the observation.

The validity of this study is sought to be ensured by using different materials: referencing older research articles and books that the newer research articles in this study have built on, and examining the collected rich empirical data from interviews and user observation. The empirical data consisted of both expert and manager interviews, and the profiles of interviewees were diverse, which allowed to discuss a variety of different topics from different perspectives. When analysing the financial administration tasks as in Table 2, the analysis could have gone one level deeper to sub-task level and might have provided additional understanding of the tasks, but that would have required additional user observations and interviews. Therefore, the characterisation of tasks was done on task level.

The third and final criteria to assess reliability of research is generalisability. Although Figure 2 provides new theoretical contribution, the framework does not capture all of the complexity of a loosely-coupled distributed cognition system and the intricate interaction happening between human agents and computers. The framework portrays a generalised illustration of information-intensive operations, but since individual and organisational sense-making is a messy, complex process, the actions might not always follow the systematic flow as it is portrayed in the framework.

6.4 Suggestions for further research

New possibilities to conduct further research emerges from this study's discussed topics and theoretical contribution. First of all, it would be intriguing to conduct a follow-up research in the case company, and examine how the new technologies have been taken in use and how those have affected the specialists' ways to carry out their work. This would provide novel insight into how automation technologies affect information-intensive work and human cognition on different levels in a complex, loosely-coupled distributed cognition system on a longer term as the organisation progresses in the automation continuum.

Moreover, it would be interesting to study how upskilling affects the way how human agents make sense compared to the situation before upskilling began and how they regard themselves with the newly acquired skills and position in the organisation. Lastly, more research could be conducted to enrich the proposed framework in Figure 2 and for example examine the topics discussed in this study together with cognitive biases and deskilling.

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Appendix A: Introduction message sent to interviewees

Hei!

Olen maisteriopiskelija Aalto-yliopiston kauppakorkeakoulusta ja teen pro gradu –tutkimusta, joka käsittelee teknologian roolia ja hyväksymistä työssä. Tulen toteuttamaan haastatteluita seuraavien kahden viikon aikana osalle Case Company X:n liiketoimintayksikön taloushallinnon ammattilaisista, esimiehistä ja johtajista, jotta saan kerättyä aineistoa tutkimustani varten. Pääset osallistumaan tutkimukseen yhtenä haastateltavista, sillä tietämyksesi ja näkemyksesi aiheesta on arvokasta.

Haastattelu pidetään Case Company X:n tiloissa ja se kestää noin 90 minuuttia, jonka aikana esitän aiheeseen liittyviä kysymyksiä, joihin voit vastata vapaamuotoisesti. Tulen äänittämään haastattelun, jotta voin palata siihen, kun työstän vastauksia auki tutkimukseen. Käsittelen kaikki vastaukset luottamuksellisesti eikä henkilöllisyytesi tule esille tutkimuksessa, jollet näin halua. Saatan lainata joitain osia vastauksistasi tutkimukseeni, mutta niistäkään henkilöllisyytesi ei tule ilmenemään.

Jotta haastattelu sujuisi jouhevasti, pyydän että mietit etukäteen päivittäisiä työtehtäviäsi ja mitä erilaisia työvaiheita ne sisältävät, sekä katsot seuraavat alla olevat videot liittyen ohjelmistorobotteihin:

https://www.youtube.com/watch?v=1nvXmB4DYWA

https://www.youtube.com/watch?v=fjdLAqgwMKA

Nähdään haastattelussa!

Appendix B: Interview questions for specialists

Haastateltavan taustatiedot

Ikä ja koulutus?

Aikaisempi työkokemus?

Aiemmat työtehtävät Case Company X:ssä?

Tämän hetkiset työtehtävät Case Company X:ssä?

Yleisiä kysymyksiä päivittäisestä työstä

Kuvaile tyypillinen työpäiväsi?

Mistä tämänhetkisistä työtehtävistä pidät erityisesti?

Mitä järjestelmiä käytät tällä hetkellä työssäsi ja mihin tarkoituksiin?

Miten työsi on muuttunut uuden järjestelmän käyttöönoton jälkeen?

Ensireaktiot uudesta teknologiasta ja teknologian hyväksyminen

Tässä on lista erilaisia taloushallinnon prosesseja. Mitä näistä prosesseista [appendix D] hoidat työssäsi?

Voitko kertoa mahdollisimman tarkasti vaihe vaiheelta, miten hoidat [taloushallinnon prosessia]? Esimerkiksi, miten syötät tietoa järjestelmään, mitä ongelmia saattaa tulla vastaan, mikä on toistuvaa ja rutiininomaista prosessissa, tai milloin sinun tarvitsee keskittyä syvällisesti, että järjestelmään menevä tieto menee oikein, ja niin edelleen.

> *Jatkokysymys*: Seuraatko selvää työjärjestyslistaa, joka on jonkun muun laatima, vai onko työjärjestys muodostunut itsestään tekemällä työtä?
>
> Siirrätkö tietoa järjestelmästä toiseen manuaalisesti?
>
> Mikä on arviosi siitä, kuinka suuri osa kirjattavasta materiaalista tulee paperisessa tai sähköisessä muodossa?
>
> Kuinka usein joudut reagoimaan odottamattomiin poikkeamiin työssäsi, joka vaatii syvää keskittymistä ja paljon ajattelemista? Pystytkö hoitamaan tällaiset tilanteet yksin, vai tarvitsetko jonkun muun apua?
>
> Voitko kuvailla, miten ratkaisit ongelmallisen tilanteen kirjanpito- tai taloushallinnon järjestelmässä tai ylipäätään työssäsi?
>
> Kuinka montaa asiakkuutta hoidat tällä hetkellä, ja koetko, että sinulla on aina riittävästi aikaa hoitaa työtehtäväsi ilman että koet olevasi ylikuormitettu?
>
> Oletko huomannut, että pienet virheet johtaisivat suurempaan ongelmatilanteeseen? Voitko antaa esimerkin?
>
> Raportoitko järjestelmässä tai työssä tulleista ongelmista tai virheistä eteenpäin, ja miten teet sen?

Johdantovideot RPA:sta:

Jos mietit johdantovideoita ohjelmistorobotiikasta, niin kuinka hyvin olet perillä siitä, mitä sen kaltaiset ohjelmistorobotit ovat?

Millaisia ensiajatuksia ja -tuntemuksia sinulle tulee ohjelmistoroboteista?

Jatkokysymys: Näetkö ohjelmistorobotit positiivisena vai negatiivisena asiana työsi kannalta, ja minkä takia?

Onko hyvä asia, jos toistuva mekaaninen työ vähenee tai jopa poistuu työstäsi? Minkä takia?

Miten käsityksesi muuttui sen jälkeen, kun olit katsonut videot siitä, mitä ohjelmistorobotit ovat ja miten ne toimivat?

Jatkokysymys: Ovatko ohjelmistorobotit mielestäsi kehittynyt ja innovatiivinen ratkaisu, jota voidaan käyttää tietotyössä?

Jos ohjelmistorobotit voisivat ottaa osan työtehtävistä hoitaakseen, mitä tekisit niistä vapautuvalla ajalla? Ottaisitko esimerkiksi enemmän asiakkuuksia hoitaaksesi vai keskittyisitkö paremmin nykyisiin asiakkuuksiin, tähtäisitkö vastuullisempaan työtehtävään, jossa on korkeampi palkka, vai jotain muuta?

Oletko valmiimpi ottamaan käyttöön uuden, tehokkaamman taloushallintojärjestelmän, jossa voit automatisoida työtehtäviä, vai ohjelmistorobotin? Mistä syistä?

Jos ajattelet yleisesti, kuinka helppona tai vaikeana pidät sopeutumista uusiin teknologisiin muutoksiin?

Miten suhtaudut uusien taitojen opetteluun, esimerkiksi uuden ohjelmiston käytön opetteluun, jossa ohjelmistorobotit saisi toteuttamaan tiettyjä työtehtäviä, kuten videoilla nähtiin?

Jatkokysymys: Olisitko valmis muuttamaan työnkuvaasi ja ottamaan uusia tehtäviä vastuullesi, esimerkiksi opettamaan ohjelmistorobottia hoitamaan tiettyjä työprosesseja? Mikä siinä olisi mielenkiintoista?

Jos ohjelmistorobotti korvaisi joidenkin tiettyjen työtehtävien hoitamisen [taloushallinnon prosessissa], olisiko vaikeampaa ylläpitää taitoja, joita tarvitset työssäsi?

Yleisesti ajateltuna, koetko olevasi hyvin perillä siitä, mitä ohjelmistorobotit ovat ja mitkä niiden todelliset vaikutukset työhön ovat?

Onko sinulle tärkeää, että pääsisit osallistumaan ohjelmistorobottien käytön suunnitteluun?

Jatkokysymys: Millä tavoin haluaisit osallistua ja vaikuttaa suunnitteluprosessiin?

Kysyttävää tai kommentoitavaa?

Appendix C: Interview questions for managers

Haastateltavan taustatiedot

Ikä ja koulutus?

Aikaisempi työkokemus?

Aiemmat työtehtävät Case Company X:ssä?

Tämän hetkiset työtehtävät Case Company X:ssä?

Yleiset kysymykset

Jos mietit työnkuvaasi, mikä tekee siitä erityisen mielenkiintoisen tällä hetkellä? Pystytkö nimeämään jonkin tietyn asian?

Miten uuden järjestelmän käyttöönotto on sujunut tähän mennessä?

Käytetäänkö Case Company X:ssä jotain tiettyjä johtamismenetelmiä, esimerkiksi Leania, Six Sigmaa tai Total Quality Managementia (TQM)?

Millainen rooli teknologialla on Case Company X:ssä ja miten tietoinen olet toimialan viimeisimmistä teknologisia kehityksiä?

Millaisen kuvan johtotason henkilöt, esim. toimitusjohtaja tai CIO, pyrkivät antamaan teknologian roolista organisaatiossa?

Onko Case Company X:llä automaatiostrategiaa? Mitkä ovat sen avainkohdat?

Kuinka paljon ja millaisissa asioissa bisnes- ja IT-toiminnot tekevät yhteistyötä?

Kun mietit rekrytointia taloushallinnon tehtäviin, esim. kirjanpitoon tai ostoreskontraan, mitä ominaisuuksia ja taitoja painotatte rekrytoinnissa?

> *Jatkokysymys*: Kuinka paljon pyritte ennakoimaan muuttuvia taitotarpeita, kun rekrytoitte uusia työntekijöitä?
>
> Miten asiantuntijatiimit ovat muodostettu? Onko tiimissäsi monipuolista osaamista?

Johdantovideot RPA:sta

Jos mietit johdantovideoita ohjelmistoroboteista, millaisia ensiajatuksia ja -tuntemuksia sinulle tulee ohjelmistoroboteista?

Kuinka hyvin olet perillä siitä, mitä ohjelmistorobotit ja Robotic Process Automation (RPA) ovat?

> *Jatkokysymys*: Näetkö ohjelmistorobotit positiivisena vai negatiivisena asiana Case Company X:n liiketoimintayksikön taloushallinnon työn kannalta, ja minkä takia?

Miten käsityksesi muuttui sen jälkeen, kun olit katsonut videot siitä, mitä ohjelmistorobotit ovat ja miten ne toimivat?

Jatkokysymys: Ovatko ohjelmistorobotit mielestäsi kehittynyt ja innovatiivinen ratkaisu, jota voidaan käyttää tietotyössä?

Onko Case Company X:llä tiekarttaa/suunnitelmaa RPA:n käyttöönoton toteuttamiseksi?

Jatkokysymys: Oletteko tehneet proof of conceptia RPA:sta?

Mitä haluaisitte saavuttaa ohjelmistoroboteilla?

Jos ohjelmistorobotit voisivat ottaa osan taloushallinnon työtehtävistä hoitaakseen, miten allokoisit asiantuntijoilta vapautuvan ajan?

Miten tietoisia alaisesi ovat, mitä ohjelmistorobotit ovat ja mitkä niiden todelliset vaikutukset työhön ovat? Oletko kuullut, että he olisivat jutelleet ohjelmistoroboteista tai vastaavista aiheista?

Jatkokysymys: Onko teillä olemassa viestintäsuunnitelmaa, jolla tiedottaisitte ohjelmistoroboteista?

Kuinka paljon etukäteen alkaisitte viestimään ohjelmistoroboteista ennen kuin alatte implementoimaan niitä?

Millä tavalla haluaisitte osallistaa asiantuntijoita ohjelmistorobottien käytön suunnitteluun?

Millaista koulutusta tarjoatte työntekijöille?

Jatkokysymys: Onko taloushallinnon asiantuntijoilla osaamista esim. opettaa ohjelmistorobotteja hoitamaan työtehtäviä? Löytyykö halua opetella uusia taitoja?

Kuinka itsenäisiä taloushallinnon asiantuntijat ovat työssään? Esim. kirjanpitäjät ja ostoreskontranhoitajat?

Jatkokysymys: Noudattavatko asiantuntijat selvää työjärjestyslistaa, joka on jonkun muun laatima, vai onko työjärjestykset muodostuneet itsestään työn ohella?

Vaihdatteko asiakkuuksia tai tehtäviä aika ajoin asiantuntijoiden kesken, vai vastaavatko he koko ajan samoista asiakkuuksista ja tehtävistä?

Kuvaile tilanne, jossa taloushallinnon työssä tapahtui virhe ja miten pyritte hoitamaan sen kuntoon?

Jatkokysymys: Pyrittekö ennaltaehkäisemään virheiden tapahtumista työssä?

Oletko huomannut, että useampi pieni virhe olisi johtanut suurempaan ongelmaan? Esimerkki?

Jos ajattelet yleisesti, kuinka helppona tai vaikeana pidät sopeutumista uusiin teknologisiin muutoksiin omasta näkökulmasta? Entä organisaation näkökulmasta?

Kysyttävää tai kommentoitavaa?

Appendix D: List of financial administration processes

Asiakasrekisterin hallinta
Tuoterekisterin ylläpito
Myyntilaskujen lähettäminen
Myyntilaskujen käsittely (laadinta, asiatarkastus, hyväksyntä ja arkistointi)
Huomautuskirjeiden käsittely
Myyntireskontran ylläpito
Toimittajarekisterin ylläpito
Ostolaskujen vastaanottaminen
Ostolaskujen käsittely
Matka- ja muiden kulujen käsittely
Ostoreskontran ylläpito
Henkilöstörekisterin ylläpito
Palkkojen perustietojen ylläpito
Palkanlaskenta
Tilinpäätöksen ja tasekirjan laadinta ja lähetys
Kausiveroilmoitusten laadinta ja lähetys, ALV
Palkkojen vuosi-ilmoitusten laadinta ja lähetys
Eläkevakuutusilmoitusten laadinta ja lähetys
Maksuliikenne, ALV
Maksuliikenne palkat
Maksuliikenne ostot, matka- ja kululaskut
Maksuliikenne kausiveroilmoitus