The indirect impacts of robotic process automation:

A case study for a Finnish healthcare organisation

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ABSTRACT

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Digitalisation affects organisations and industries in many ways, and healthcare is no different. One of the technologies transforming healthcare and the way people work is robotic process automation (RPA). One of the most common reasons for automating a process or task with RPA is to free up the time of experts to allow them to focus on more value-adding work. The direct benefits of automating a task with RPA have been thoroughly researched and are the driving force behind how a business case for developing an automation is created. But robotic process automations bring more changes about them than simply the planned, direct benefits.

This thesis inspects the processes and people around automated tasks, with the focus of identifying indirect impacts a number of robotic process automations have had in a Finnish healthcare organisation. A total of five automations were studied and eight subject matter experts were interviewed to gain an understanding of the indirect impacts of the automations that were in place in units like finance, IT, HR and the dermatology outpatient clinic. In the final section of the thesis, the findings based on the held interviews are presented. Additionally, suggestions are given for improving the processes from an impact monitoring perspective, as well as future research ideas and thoughts on how to better be able to measure the indirect impacts in general and to find the ways in which a single robotic process automation can actually affect the processes and the work of the people linked to the process that had been automated.

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Digitalisaatio vaikuttaa organisaatioihin ja toimialoihin monin tavoin, myös terveydenhuoltoon. Eräs terveydenhuollon alalla digitalisaatiota mahdollistavista teknologioista on ohjelmistorobotiikka (RPA). Yksi yleisimmistä syistä automatisoida prosessi tai tehtävä ohjelmistorobotiikan avulla on vapauttaa asiantuntijoiden aikaa, jotta he voivat keskittää ajankäyttöään arvokkaampaan työhön. Ohjelmistorobotiikan tuomia suoria hyötyjä on tutkittu laajalti ja niitä käytetään usein automaatioprojektien liiketoimintatarkasteluissa. Ohjelmistorobotiikan automaatiot tuovat mukanaan kuitenkin muitakin hyötyjä kuin etukäteen lasketut, välittömät hyödyt.

Tässä tutkielmassa tarkastellaan prosesseja ja ihmisiä prosesseissa, keskittyen ohjelmistorobotiikan tuomiin välillisiin vaikutuksiin suomalaisessa terveydenhuolto-organisaatiossa. Työssä tarkasteltiin viittä automaatiota ja haastateltiin kahdeksaa prosessiasiantuntijaa, jotta pystyttiin luomaan kuvaa organisaation automaatioiden välillisistä vaikutuksista muun muassa taloushallinnossa, henkilöstöhallinnossa ja ihotautien poliklinikalla. Työn viimeisessä osuudessa esitellään haastatteluiden pohjalta tehdyt löydökset. Lisäksi annetaan ehdotuksia siitä, kuinka prosessien vaikutusten seurantaa voisi parantaa ja käydään läpi jatkotutkimusideoita sekä ajatuksia siitä, kuinka välillisiä vaikutuksia voisi huomioida ja ennakoida paremmin. Yksittäisen ohjelmistorobotiikan projektin vaikutukset ulottuvat moniin prosesseihin ja henkilöihin, joiden työ liittyy automatisoitavaan prosessiin.

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ABBREVIATIONS

API	Application Programming Interface
BPM	Business Process Management
CoE	Centre of Excellence
IoT	Internet of Things
KPI	Key Performance Indicator
MRI	Magnetic Resonance Imaging
RPA	Robotic Process Automation

Table of contents

Appendices

Diagrams

Tables

1. Introduction

With the fourth wave of industrialisation has also come the concept of digitalisation, a global megatrend. Making processes more digital and, with automation technologies, less manual has never been more topical than in today's world. Green transition, going paperless and automating tasks involving the so-called legacy systems, i.e., business applications that do not have APIs, are just some of the contemporary themes pertaining to digitalisation. Automation has played a large role in the progress of modern society, so it cannot be considered as a completely new phenomenon (Singh, Tiwari & Singh 2009).

The first wave of industrialisation came in the form of the revolution brought by steam and hydro power in the beginning of the 19th century. The second wave of industrialisation occurred at around the turn of the 20th century with the invention of electricity and its widespread use. Past the midway of the 20th century, as microchips, processors and computers became the newest innovations, the third wave of industrialisation took place. It can be said that digitalisation started with the third wave. Now, continuing from the traction of the third wave, with the technology boost brought by contemporary technologies and concepts like self-learning algorithms, big data analytics and robotic process automation, the fourth wave of industrialisation is upon us. These new technologies have revolutionised the communication between humans and computer systems as well as the interaction between the two. (Vuorinen 2016; Schwab 2016; Schäfer 2018)

Each of the aforementioned waves of industrialisation has hastened the transformation of industrialism and society with technological advances like social media, the internet of things, the industrial internet of things, cloud technologies and robotics (Kaya, Türkyilmaz & Birol 2019; Kuruczleki, Pelle, Laczi & Fekete 2016)

The fourth wave is expected to eventually have a larger impact than any of the previous waves of industrialisation have had, thanks to the speed at which it enables change and the breadth of the change along with its effects on systems. It is worth noting, however, that there are also counterarguments that predict that the sum of current and future innovations will not exceed the impacts that the previous industrialisation waves have had (Kuruczleki et al. 2016; Schwab 2016).

Digitalisation has changed the ways in which the businesses and, to generalise further, people of today acquire information. Whether it is receiving daily sleep cycle measurements from one's smart phone or finding new ways to engineer business processes to make them more efficient and cost-effective, as competitiveness evolves rapidly, digitalisation has forced organisations to react more quickly to the paradigm shift on the market by looking into updating their company culture and core skills.

New technologies drive change in organisations, which increases efficiency, but they also change the way of working, create new jobs, change processes and lead to new business models. There is some concern that automation may lead to a jobless future, but the automation potential of jobs tends to be often overestimated. In most jobs, the bulk of tasks requires cognitive capabilities but there are still many automatable, routine tasks. (Arntz et al. 2016)

The change brought by the technologies pertaining to the fourth wave of industrialisation is not of course limited to the business world; it is also very much prevalent in public sector and healthcare. Whilst in the majority of cases commercial organisations have been the trailblazers in adopting these new ways of standing out on the market and leveraging technology to gain an edge over their competitors, healthcare has actually been amongst the first adopters of robotic process automation, with the University Hospital of Birmingham jumping on the bandwagon in the mid-2010s.

Robotic process automation, often abbreviated to RPA, is a term used for software applications which allow for the creation of automations that use the user interfaces of business applications. In many ways, automations built with RPA can be thought of as immaterial digital workers which perform certain tasks or parts of a business process by accessing applications and reading, extracting and writing data just like a human user might. An example could be to read the contents of a spreadsheet file and input them to an application like SAP or a patient data system. Even though RPA applications are most often used to automate applications that do not have APIs, they can be used to send and receive data through APIs as well (Brynjolfsson & McAfee 2014; Kaarlejärvi & Salminen 2018; Ilmarinen & Koskela 2015; van der Aalst et al. 2018).

RPA is an automation tool with which the work done by human users in applications can be emulated. It is a cost-efficient way of executing manual, repetitive tasks quickly (Asatiani & Penttinen 2016). Robotic process automation can be said to be its own wave of innovation within the fourth wave of industrialisation because of the benefits it has the potential to bring (Lacity & Willcocks 2016a; van der Aalst et al. 2018). In fact, the application of RPA has been considered to be essential for any company in order to maintain a competitive edge (Makadam, Holmukhe & Jaiswal 2019).

The characteristics of RPA allow it to be used in a variety of tasks and processes, but most importantly its benefits become apparent with high volume, rule-based tasks, where repetition is commonplace, the instructions for what to do can be broken down to simple yes-no type of questions and the data is in a structured format. Even with these limitations and requirements, there are plenty of use cases for RPA in organisations of all types, and with the intention of digitalising more and more tasks and processes, organisations can find even more places for applying RPA across their functions.

With robotic process automation, organisations have successfully reaped benefits of many kinds, e.g., cost saving, more flexible operations, improved quality of services, improved accuracy and precision, error reduction, and diminishing siloes between their business functions (Chappell 2016; van der Aalst et al. 2018; Aguirre & Rodriguez 2017; Lacity & Willcocks 2016a).

As RPA and technology in general progresses, both employees and companies will face the need to learn new skills and to find business solutions to keep up with the rapidly evolving digital transformation taking place everywhere in the world (Sousa & Rocha 2019). Likewise, as technology progresses and organisations become more and more dependent on digital solutions, the risk of falling prey to a cyber security attack also rises. This has slowed down the full adoption of new technologies somewhat (Zhu, Hu, Ahn & Yau 2012).

With digitalisation and automation, the profile of work changes in many jobs. With more and more routine knowledge work being automated, an increase in more expertise requiring work is expected, along with completely new types of bright talent.

RPA brings direct and indirect benefits, some easier and simpler to measure than others. The goal of this thesis is to shed light on some of the more intangible effects and impacts the application of RPA has had on a Finnish public healthcare sector organisation by looking into a selection of administrative, financial and clinical process automations in their environment.

Whilst the patient-facing work of nurses and medical doctors is something that cannot be fully automated or digitalised, there are ways of making their work less complex by reducing the amount of time spent sitting in front of the computer, allowing them to focus more on their core activities, i.e. working with their patients.

1.1 The background of the research

Robotic process automation is a term referring to the usage of software-based automations which are able to utilise the user interfaces of applications like a human user would. This opens up more possibilities for automation in organisations as data can be transferred between systems without human intervention even if there is no integration between them. Although these software robots are not self-learning and cannot structure unstructured data, there are many routine, rule-based processes and tasks where RPA can be utilised.

After a pilot in 2015, a public healthcare organisation in Finland with over one million annual customers and patients started its robotic process automation program in 2018. Since then, dozens of process automations designed to lessen the routine, mundane knowledge work of hospital staff have been developed. Due to a fragmented IT environment with hundreds of applications with little integration between them, prior to the introduction of robotic process automation, the hospital staff had to input patient details to multiple systems instead of just one.

Even though the time saved with these automations was significant, one of the major challenges the healthcare organisation was facing was to measure how the impacts of process automations show elsewhere in the organisation. An additional challenge for the RPA team was that it is its own unit residing within the IT, far from the healthcare units. This meant that the visibility to the core processes, e.g., within the care processes was very low. Determining and measuring the direct benefits an automation brought to the unit it was developed for was straight-forward. But in which other ways did it affect the organisation? Which processes benefited from the improvement of another process?

Impacts of various innovations in organisations have been studied through decades. Many different kinds were gone through for this thesis in order to gain an understanding of possible indirect benefits and drawbacks the modification of a business process might have for its organisation. It has also been shown how outsourcing has its own hidden benefits (Frank 2000): By shifting work from the employees of an organisation to elsewhere, IT costs were reduced due to fewer computers required. Also, employees were less dependent on the systems used as they no longer had to be using as many as before. This in turn led to a smaller risk of productivity loss. With fewer problems, the reputation and trustworthiness of IT also improved.

In 2009, a study about the impacts on Salesforce automation was performed (Boujena, Johnston & Merunka 2009). Among the identified benefits were improved transparency as the flow of information was clearer, increased effectiveness, availability and product knowledge, satisfaction with the salesperson and improved image of the salesperson, supplier and brand. A 2017 paper about the unexpected benefits of digital transformation mentions that the implementation of digital technologies will create new opportunities for working in a different way, which in turn shall bring new opportunities for infusing technology into work processes (Kane 2017). In 2016, a review into the impact of the redesign of care processes was conducted. It revealed dozens of direct and indirect benefits that had realised (van Leijen-Zeelenberg et al. 2016).

Despite there being multiple papers on the realised benefits of the implementation of robotic process automation, research focusing on the indirect impacts was rarer. When the automation of a task is pushed into production, it directly affects the team that has been executing the task manually. The time allocation of these subject matter experts can then be focused elsewhere, typically to tasks that provide more value to the organisation like customer-facing or patient-facing work.

However, from a process excellence perspective, without adequate communication and guidance, it is possible that automating a task will simply shift the bottleneck from one step in the end-to-end process to the next. Some of the goals of this thesis were to find out how the end-to-end process was affected by the automation of a task in the process, whether its impacts show on the process steps elsewhere (for instance before or after the automated one or in other processes due to the readjusted focus of the subject matter experts), and how a process can be engineered so that its indirect impacts become more visible to both the automation development unit and the healthcare unit.

1.2 The goals and scoping of the research

The main goals of this research are to find out what kind of indirect impacts various robotic process automations have had in a Finnish public healthcare provider and provide a framework for mapping and measuring indirect impacts of process automations in general. A total of five process automations are in the scope. The focus is not on the technical features of the automations, but on what they enable for the healthcare organisation.

The main research question is: "What kind of indirect impacts do robotic process automations have in the healthcare organisation?"

The above can then be broken down to five subquestions:

"How does the process, for which the automation was created, change?"
"How does the work of the people, whose work has been automated, change?"
"How do end users, e.g., customers, patients or healthcare professionals, benefit from the process automation?"
"How does the healthcare organisation benefit from the process automation?"
"How to consider indirect impacts when building a business case for developing an automation?"

This thesis contains a theoretical section based on a literature review as well as an empirical section based on interviews. The sources of the literature review are international research papers.

There has been some research made on the indirect impacts of process automations, but the more intangible the impacts are, the more difficult they are to determine. A single task automation can have a snowballing effect on the execution of a business process as a whole, but the further the investigation of the impacts moves in the process from the point of the automation, the more challenging it is to prove that any changes in any key performance indicators are due to that automation. This research acknowledges that fact and thus is scoped to focus on the secondary impacts instead of tertiary or further. Process automation is one way of making a process more efficient, and the outcome of just how much the automation improves the process should be able to be measured. Direct benefits are much easier to determine and are often the only ones based on which a business case for developing an automation is built. One of the goals of this research is to provide the means to also take indirect impacts into account on some level when building business cases.

Often the mentioned impacts and benefits of robotic process automation are either estimates or are purely focusing on the task that has been automated, rather than on what is happening around it. Around the automated tasks, two perspectives can be considered; that of the people whose work has changed due to a "digital worker", and the other steps in the business process.

1.3 Research structure

This thesis has been split into five main sections. The first section is introductory, presenting the goals, scoping and background of the research, the chosen research methodology and a view into past literature on the topic being researched here. The second section, literature review, has two theoretical parts. The first is about healthcare, the ongoing digital transformation happening in the industry and its identified impacts. The second theoretical part is about robotic process automation, its capability, requirements, limitations and impacts. The purpose of the two theoretical parts is to provide a wider view into the impacts robotic process automation has had and can have in healthcare either by itself or as a part of a broader digital transformation program. The third section describes the research methodology used, and the fourth section is about the empirical part of the research, where some process automations developed for the healthcare organisation are presented and the results gathered from the interviews are presented. The fifth section concludes the thesis with conclusions, thoughts, process improvement suggestions and ideas for future research.

2. Literature review

Even though automations have been made and developed in organisations throughout the past decades, robotic process automation solutions are still relatively new, with their adoption starting during the 2010s across industries, business functions and countries. The literature review focuses on the capabilities, requirements and benefits of RPA and its potential to transform business as well as on digital transformation in healthcare.

2.1 Digital Transformation in Healthcare

In this modern world, digitalisation has strongly affected the operating ways of organisations. With new digital tools becoming available more and more on the market, enabling the transformation of business processes to become more efficient, agile and meet compliance requirements, amongst other things (Kirchmer & Franz 2019).

Closely related to this is process excellence, i.e., the reshaping of a process to make it more efficient and have better quality. Both private and public healthcare organisations are facing changes and challenges all over the world whilst being under significant pressure to improve their performance and enhance their processes (Ratia et al. 2018). A study compiling case studies where care processes had been redesigned by applying LEAN thinking and the Toyota production system, without any technology, showed to have many positive outcomes in the efficiency, effectiveness and safety of a hospital. The study lists, among others, a significant decrease in the mean time spent in the emergency department, higher diagnostic accuracy, fewer false-negative diagnoses, fewer patients having to have surgery, the capability to have more central lines in a given time period, reductions in waiting times, significantly fewer episodes of ambulance bypass and a decrease in specimen turnaround time (van Leijen-Zeelenberg et al. 2016). Improving a process does not necessarily require adding any new technologies to the process, but process excellence and technology often go hand-in-hand. This is then called digital transformation. Digital transformation can also be business transformation through the means of technology. Digital transformation is a phenomenon with which cost reduction, optimisation and the production of new services, for instance, can be done in completely new ways widely because of novel technologies like the cloud, the Internet of Things (IoT) and big data, and the transformation can happen in many different ways like organisational structures and business operations (Nasiri 2021). Patient flow and patient pathways are the classical models of value chains within the healthcare industry and the healthcare industry likely to benefit highly from the implementation of Industry 4.0 technologies and concepts (Thümmler & Bai 2017).

A 2011 study explored the direct, indirect and strategic benefits of RFID adoption in healthcare (Bunduchi, Weisshaar and Smart 2011). Some of the key findings were improved process transparency and that as time passed the indirect impacts of the implementation became more evident in the organisation. The study also found negative impacts that had not been taken into account during the implementation project, like the retraining costs of the subject matter experts.

The core processes of Finnish healthcare have been mapped and visualised as a national project that was completed in 2011. The goals of creating a generalised visualisation have been to enable the technical capabilities from a national perspective, to enable the improvement of efficiency and to emphasise the part of the patient in the process (Vuokko et al. 2011). One of the visualised processes can be seen in diagram 1. The medical care process in instititutional care involves the patient, the healthcare professional, the patient data system and the data management service. The diagram shows how the interaction between the healthcare professional and the patient, and the healthcare professional and the patient data system happens.

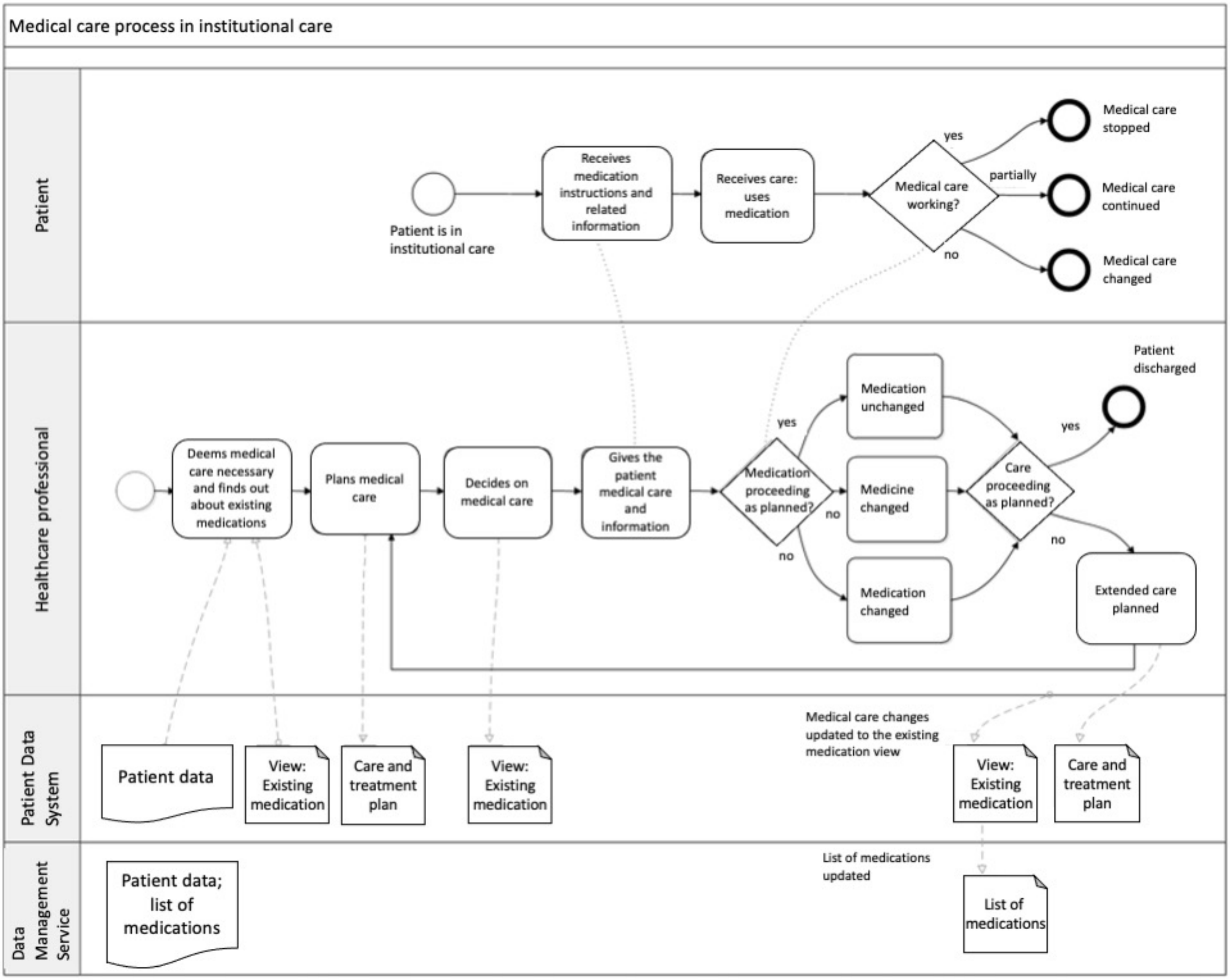

Diagram 1. A visualisation of the medical care process in institutional care. Translated from Terveydenhuollon toimintaprosessit - Terveydenhuollon yleiset prosessit ja niiden tarkennukset (Vuokko et al. 2011).

2.2 Robotic Process Automation

This section delves into the concept of robotic process automation. The purpose of this section is to help explain the characteristics of RPA before proceeding into the process automations and the interviews targeted by this research. In the first subsection a general view into RPA is given, whilst the second subsection focuses on how to automate with RPA. The third subsection is about the characteristics that make for a feasible target for robotic process automation. and the fourth subsection is about the benefits RPA can bring if its prerequisites are met.

The possibilities of using RPA in healthcare are vast. In a study by Ratia et al. (2018) regarding the use of robotic process automation in healthcare, the people who were interviewed said that every healthcare process could be enhanced with RPA.

2.2.1 Robotic Process Automation in general

As mentioned in the introductory section, the direct benefits of RPA have been already relatively widely documented and studied, but the indirect impacts, whether positive or negative, have been less so. As a technology the capabilities, features and potential of robotic process automation are already well known, including the challenges that organisations may be faced with when automating their core IT systems. Simply looking at the number of case studies performed around the world with regard to RPA shows how the intent to leverage it, especially in larger organisations where transaction volumes tend to be higher. Robotic process automation solutions can be ones that work locally on a user’s desktop PC or independently on a virtual machine in the cloud (Hindle, Lacity, Willcocks, Craig 2018).

Robotic process automation can be considered to have sprouted from macros and scripts. Another source from where it can be thought to have derived is desktop automation, which is the execution of small, single tasks with macros using structured data (Penttinen et al. 2018, van der Aalst et al. 2018, Kokina, Blanchette, 2019). In a business environment, the most well-known instance of the use of macros is with the spreadsheet software Microsoft Excel, where macros can be used to automate different functions and actions of the software (Rozario et al. 2018). Software agents are also a type of macro or script. Software agents have been utilised in automating the work of end users on their desktops. However, a software agent works strictly by utilising the APIs of different applications, rather than the user interfaces (Jansen & Pooch 2004; Asatiani & Penttinen 2016). However, unlike macros, robotic process automation solutions are able to work with any number and type of software applications and move data between them by reading, extracting and modifying data as needed. Robotic process automation solutions work independently and do not require human intervention, as long as the process is rule-based enough (Kokina, Blanchette 2019).

Robotic process automation solutions can be instructed to read emails, open files, identify data, send emails or submit information to various systems (Rozario et al. 2018). The definition of robotic process automation is the automation of knowledge work tasks performed by human users. These automations are colloquially called robots, digital workers or virtual colleagues to drive in the point that they execute the process in many ways like a human would. The goal of a robotic process automation is to automate as much of the task as possible. Often, due to process complexity and the limitations of RPA, the automations are not able to handle a hundred per cent of the cases in the process. The unhandled cases are passed down for human expert to handle. This also makes the automation feel more like an invisible colleague that takes care of some of the work but leaves the rest to the subject matter experts. RPA solutions are used in processes where the number of transactions is high and the decision making is rule-based enough within the process that it can be broken down to simple yes-no questions (Kaya et al. 2019, Willcocks et al. 2015a). In other words, it can be stated that to function correctly, robotic process automation solutions require precise and detailed, rule-based commands and steps which the automations are then able to repeat as many times as needed (Kaizer, Ponce & Steinhoff 2018).

When needed, RPA robots are also to communicate to humans when a task or a transaction has been performed or when there are errors with which the robot is unable to deal (Fernandez & Aman, 2018). It is also worth noting that RPA does not modify or interfere with existing applications in the IT environment, as it utilises the user interfaces of applications and can also react to changes happening there (van der Aalst et al. 2018).

2.2.2 Automating with RPA

Basic RPA can be used to automate tasks in two different ways. The first way can be described as attended automation, or a robotic assistant, and the second way can be described as unattended automation.

In attended automation, RPA robots assist the user in their tasks on the desktop of the user, but do not handle the larger wholes by themselves. Attended automations tend to be shorter and simpler. For instance, if a human user has previously had to copy information from one system to another, they can now, with the click of a single button, make their robotic assistant perform that task for them, accurately, reliably and consistently. After the task has been performed, the human user may use their desktop again. Using the machine whilst the robot is working will lead to exceptions and cause the automation to fail. These types of automations make the workday of individuals easier and less monotonic (Mullakara et al. 2020). A key presumption with attended automations is that they perform the task faster than the human would or that the human is at least able to do other tasks whilst the robot is using their desktop.

Unlike attended automation, unattended automations work independently either and can be either triggered or scheduled to run. An unattended automation does not work on the desktop of a user, but rather on a completely separate machine, reserved for digital workers to perform unattended automations. These types of automations can be run at any time of the day, as their functionality is not dependent on whether a human user has their machine running or not. Once the robot has performed its duties, it sends a report on the proceedings where the human users can see which cases were successfully handled and which were not, and what the reason for unsuccessful handling was (Mullakara et al. 2020). This brings transparency to the process so that what the automation is doing is not a black box.

It is less risky to automate processes that have existed for a long time and the workflows of which are very familiar to the human users in the team performing the task, as the outcomes and costs of these kinds of processes are much easier to estimate (Rozario et al. 2018). Nevertheless, choosing what to automate can be challenging. Several studies have however shown the types of criteria for direct benefits and impacts that can be used as a basis for deciding whether to automation a process or not (Fung 2014, Slaby 2012). Digital workers are well-versed to perform a variety of duties and tasks, but the more automatable processes are ones where the flow of the process is clear and where creative thinking is not required at all. Processes and tasks where manual labour is needed more than subjective analysis are potentially viable for robotic process automation (Frey & Osborne 2013). For more complex processes where basic RPA cannot handle an adequate percentage of tasks, cognitive RPA can be leveraged. Cognitive RPA is an RPA solution that is connected to an artificial intelligence technology to enable the structuring of unstructured data (Burnett et al. 2018).

2.2.3 Determining the RPA feasibility of a process

Robotic process automation has generated a lot of attention in the business world due to its applicability to many kinds of business challenges. RPA can be applied to many different customer interface and support function related processes. The application can happen across business functions and organisations (Davenport & Kirby 2016; Lacity & Willcocks 2016a). But not every process or task is feasible for RPA. Certain characteristics must be found in the task or process in order for it to make sense to automate both in terms of the effort required and the cost of development. These characteristics may not be known until a thorough mapping of the process steps, also known as process definition, is performed (Lacity & Willcocks 2016b; Fung 2014).

As a rule of thumb, the more transactions a process has, the more effective it is to automate. Processes that are executed at standard intervals, adequately often and have a significant amount of cases to be handled on a regular basis are recommended. Some case studies also emphasise that even if the number of transactions is small, but the process is very important to the business, its automation may be sensible. For instance, the estimated costs of the automation should also be considered; when the costs of the automation are lower than the costs of performing the task manually, it is usually feasible to automate it. This will, however, mean that the organisation must be aware of the costs of the manual process before such an estimate can be made accurately (Fung 2014; Fersht & Slaby 2012; Asatiani & Penttinen 2016).

In tasks that must be performed outside of business hours, like during the weekend, during holidays or at night, the cost of having a human employee perform the tasks will generate more costs than during business hours, therefore making it a stronger business case for a robotic process automation project. Another characteristic for a process that makes it more feasible for robotic process automation is the number of systems accessed whilst performing the task. Accessing multiple systems manually can lead to an increase in human errors, diminish performance and as a worst-case scenario cause significant extra costs for the organisation (Ajao et al. 2018; Mindfields 2017; Fung 2014).

RPA can be leveraged in the automation of processes the more efficiently, the more stable the existing IT environment is. Updates to the systems can make the developed automations go wrong (van der Aalst et al. 2018; Asatiani & Penttinen 2016; Fersht & Slaby 2012; Fung

2014; Penttinen et al. 2018). Many RPA solutions have been implemented in environments where the number of the so-called legacy systems is high. These older systems tend to have a slower update rhythm and are therefore good targets for RPA. An unstable IT environment exposes the automations to volatile and unpredictable behaviour (Penttinen et al. 2018, Rutaganda et al. 2017). The stability of a business process should also be considered, i.e., the business rules of the process should not be constantly changing.

Legacy systems are a good target for RPA also due to them likely being more towards the end of their lifespan. Replacing these systems with new ones is happening at some point. And, with an older system being replaced in the relatively near future, there is a lack of desire to perform a costly, unfeasible and perhaps technically impossible development project to extend the capabilities of the system. Instead, RPA can be used to create an approximation of the capability update (Fung 2014; Slaby 2012; Vishnu 2017; Kääriäinen et al. 2018; van der Aalst et al. 2018).

Before automation, processes may need to be re-engineered and streamlined in order to make the implementation of RPA easier. Even though the automation can be made to pass all exception cases to be manually handled by human users, if the number of exceptions is high, it will hardly be a standardised process or automation. Also, when a digital worker faces many exceptions, the throughput time of the business process can suffer, leading to smaller business gains. It is important to find a balance between what should be handled by a digital worker and what should be handled by a human worker. (Fung 2014; Fersht & Slaby 2012; Asatiani & Penttinen 2016, Lacity and Willcocks 2016a, Kääriäinen et al. 2018)

The data in the process should also be structured and of good quality. Structured data means that each piece of data resides in such a place in a document or table that a robot can always extract it from the expected position without any analysis needed. The quality of the data refers to there being few errors within the pieces of data. RPA robots, unless very specifically instructed, cannot fix errors in data but rather utilise it as-is (Kokina, Blanchette 2019; Kääriäinen et al. 2018).

Finally, the easier it is to split the to-be-automated process into clear subprocesses, the easier it becomes to build the decision-making logic into the automation. Clear and obvious rules and streamlined subprocesses make the flow of the process less ambiguous. This way the process can also be automated subprocess by subprocess, rather than tackling the whole process in one go. Also, if it transpires a subprocess is not suitable for RPA, the other subprocesses can still be automated as planned (Lacity & Willcocks 2016b; Asatiani & Penttinen 2016; Fung 2014; Fersht & Slaby 2012). The faster an automation is in production, the faster it generates business benefits to the organisation.

2.2.4 Benefits of RPA

When the required criteria are met, the automations will bring many types of benefits. Quick and easy implementation, improved accuracy, faster process throughput time, improved process efficiency, time savings of the human users and improved process productivity. Also, with a standardised way of working, zero human errors and impeccable punctuality, digital workers improve the predictability of processes (Seasongood 2016; Lacity & Willcocks 2016a; Willcocks et al. 2015b; Willcocks et al. 2015a; Asatiani & Penttinen 2016).

Other, more indirect benefits of RPA are the scalability and the retrainability of the digital workers. If the business process has so many transactions that a single robot cannot handle it all before a given deadline, another robot can be allocated to help with the workload. If any changes are made into the business logic of a process, the change only needs to be trained to a single robot once, and it will be updated to every robot executing the same business process, and the training only needs to be done once. This is a far more cost-effective option than retraining staff (Willcocks et al. 2015a).

As work tasks get automated, the time previously spent by human workers on the tasks manually can be directed towards other, more value-adding activities like meeting customers, problem solving and decision-making (Slaby 2012). Also, the business logic of the process becomes easier to change later on, since all that is required to adapt the automation to the change is to alter the clear rules made for the robot or the graphical process workflows (Asatiani & Penttinen 2016).

The improvement of process monitoring, process quality and data are also mentioned as benefits of RPA. Due to the reporting and monitoring capabilities of the RPA softwares, it becomes much easier to determine the speed at which the process is being executed as well as easy-to-interpret and accurate statistics on the amount of transactions per process in a given timeframe. The data generated by RPA can then be used in the decision-making process of the organisation. For instance, the most common exception scenarios could be identified based on the data, and the automation could be developed further to be able to handle those scenarios if it improves the business case sufficiently (Lacity & Willcocks 2016a, Vasarhelyi 2013, Slaby 2012).

Some benefits include RPA being a valid alternative to the outsourcing and offshoring of processes. By being able to forgo the outsourcing of a business process, an organisation avoids the costs relating to the outsourcing and the oft-hidden expenses having to do with managing the offshored work and any misunderstandings. Additionally, the adoption of robotic process automation can help a company to avoid taking a hit on their image, which can occur when the news of shifting work to another geographical location with cheaper labour costs breaks out (Bals et al. 2015; Asatiani & Penttinen 2016).

Van der Aalst et al. (2018) have mentioned in their work that the more repetitive and recurring transactions a process has, the more likely it should be automated with more traditional automation methods. However, the majority of processes are ones where the volumes are not high enough to make a case for a traditional automation project due to the costs and effort the project would entail. The flexibility and agility of RPA make it a fitting automation technology for automating the processes that fall short of having a business case for traditional automation.

3. Research methodology

The research has been done by using the qualitative research method. The basis of qualitative research is the depiction of real life and the thorough examination of the chosen target (Hirsjärvi, Remes & Sajavaara 2009). Its purpose is not to reach a statistical generalisation but rather to depict the phenomenon being researched by giving it a fit for purpose, theoretical explanation whilst gaining an understanding of the inner workings of the target of the research (Tuomi ja Sarajärvi 2009). In qualitative research it is common to focus on a very small number of cases, which are then analysed in as much detail as possible (Eskola & Suoranta 1998; Hirsjärvi et al. 2009).

For this research, the qualitative material has been collected with individual interviews with the semi-structured and themed interview method. A themed interview is based on pre-determined themes and is flexible in its structure to allow space for the personal experiences and thoughts of the interviewees (Metsämuuronen 2006; Koskinen, Alasuutari & Peltonen 2005; Hirsjärvi & Hurme 2008). A total of eight subject matter experts, representing five different process automations, were interviewed. The process automations were chosen in cooperation with the healthcare organisation, and the interviewees were picked based on their roles pertaining to the team whose work had been automated. Each interview lasted about thirty minutes and was held online using Microsoft Teams. Each interview was also recorded and transcribed to help with the interview analyses.

Unlike quantitative research, qualitative research does not consider statistical probabilities as leads for the research (Alasuutari 1999). The material for a qualitative research is collected from real life situations and the primary sources for information are people. One characteristic of qualitative research is the uniqueness of each case, which must be taken into consideration in the analysis of the results. Researching the topic in a qualitative manner enables the simultaneous inspection of multiple factors (Hirsjärvi, Remes & Sajavaara 2009). This way the interviewees are able to express their opinion more freely and bring up things that the interview questions might not have considered.

The qualitative research method was also more fitting than quantitative, as the number of interviewees was not going to be high enough to have statistically significant results. Had multiple healthcare organisations and their corresponding teams and process automations been studied, a quantitative approach may have been valid.

4. Results

This section presents the automations and the results of the interviews. The set of questions used in the semi-structured interviews was designed to be able to gain an understanding of the impacts the automations had had on not only the subject matter experts' daily routines, but also on the processes relating to them. This way it became easier to indicate how and where the automation has had impacts. The healthcare organisation already had multiple automations in place, and it was important to be able to point out the impacts a particular one has, so that those impacts could be used to calculate a business case for an automation more accurately. Eight people were interviewed in total, of which four were medical doctors and four were managers. Table 1 presents the automations, processes and the roles of the people interviewed.

Table 1. The automations, their pertaining processes and the owning units, and the roles of the people interviewed.

Automation	Process	Interviewed experts	Unit
A	Patient data consolidation	Team Manager	IT
B	Logging of short-term employment contracts	Team Manager	HR
C	Scheduling of pre-agreed doctors' appointments	Medical Doctor, Medical Doctor	Healthcare
D	Digital clinical pathway on-boarding	Technical Support Manager, Medical Doctor, Medical Doctor	Healthcare
E	Allocation of purchase order invoices	Team Manager	Finance

4.1 The Automations

A total of five process automations were studied in this thesis. Automation A was an automation for a process where multiple instances of a single patient's data were consolidated into one. Automation B was an automation for a process where the on-boarding and off-boarding of short term, temporary employees was handled. In Automation C, the process was one where pre-agreed medical doctors' appointments were scheduled. Automation D was made for a process where, up to three weeks before an appointment, the patient was on-boarded on a completely digital clinical pathway. Automation E was for a process where purchase order invoices needed to be allocated to the correct entity.

4.1.1 Automation A: Patient Data Consolidation Process

For a multitude of reasons, multiple instances of a patient may exist in a patient data system, and in each instance the patient has a different Finnish social security number. This is often due to the patient either not having an official Finnish social security number or them having been brought in without any documents of identification, thereby making it difficult to verify their identity, unless the patient can remember their social security number correctly. The local patient data systems require each patient to have a Finnish social security number before any data can be logged, so a temporary one is sometimes needed to be given for that particular instance. Then later on it may transpire, for instance, once the patient regains consciousness, who the patient is and that they have previous medical history. When this happens, the medical professionals send a patient data consolidation request to a team who will then look into the matter and consolidate all hitherto known instances of the patient. This procedure may reveal, for instance, the medical allergies of the patient, which can be a life-saving piece of information for the healthcare professionals.

The consolidation process itself is very straightforward. A support ticket is raised and it appears in an IT system. The patient’s data is then looked for in and extracted from four different systems, and the findings are consolidated so that the patient only has one patient profile in the systems with all the previously separately available information. Once the consolidation is complete, the support ticket is marked as completed and the requester is notified of the completion.

The first reason for automating this process was that the consolidation requests should be handled daily, but due to limited resources it was not the reality of the matter. The second reason was that the request process would become faster. Often the support tickets would be in a pending state, waiting to be handled for multiple days. The third reason was that the time spent on these support tickets could be used elsewhere.

4.1.2 Automation B: Logging of short term employment contracts

Short term employment contracts are very common in the healthcare industry. As the number of regular staff on the books is restricted, temporary workers are used to tackle the fluctuating amounts of demand for different healthcare services. For instance, a temporary employee can be employed by one heath care unit for a month, and then by another for another period of time, for another hourly rate. This can easily lead to situations where the employment details of the person are not updated properly in full. As an example, the person may be getting paid the wrong amount; or keep getting paid after their employment with the hospital has ended; or not get paid at all, all due to human admin errors.

The first step of the process was to gather files and forms of varying formats containing employment details like the start date and the end date, after which the people found in the files are sought for in the HR system. The people's new employment details are updated to the system, or added if they could not be previously found. If a person's wage details need to be updated, a request must be raised. Finally, the end date of the employment is updated to be the day after the actual employment ends.

The reasons for automating this process were simple: updating the details was deemed very time-consuming and the volumes were great. It had been estimated that the number of temporary contracts would double over the course of a year, so automating the process was seen as a way to manage the significant rise in volumes.

4.1.3 Automation C: Scheduling of pre-agreed doctors' appointments

The schedules of patient-facing healthcare professionals, especially those of specialist medical doctors', are always very full. The costs of the resources are so high that it is vital for hospitals to optimise the time of the specialists as well as possible. In this particular unit for which the process was automated, there were only a few medical doctors and nurses, and appointments were booked three months prior to the visit. This was because those three months were presumed to be fully booked, and due to lack of time it was faster for those booking the appointments to go directly to look at the schedules three months from the current date rather than scouring through the first three months in the hopes of finding a suitable time slot. With this booking done manually, it was not unheard of that an appointment was accidentally booked on a date when the healthcare professional was not actually available. This was often noticed only a few days before the booked appointment would have taken place. This meant that another time had to be booked, again three months later. Therefore, it was possible that patients had to be waiting for six months or more for their appointment.

The process does not have many steps: a “to-be-scheduled” list of tasks is gone through and appointments are booked based on the list. Then the registration of each patient is finalised, and they are sent digital letters with attachments to notify of the successful appointment bookings.

The process was automated for four reasons. The first reason was the large number of to-be-scheduled appointments, taking more time from the team than was possible to allocate for it. The second reason was the fluctuation of the daily volumes of the appointment, making it difficult to prepare for the task beforehand. The third reason were the unused appointment time slots, missed by the manual workers due to time constraints. Finally, the fourth reason was low employee retention, making the workflow of the unit unstable due to a constant stream of leavers and starters.

4.1.4 Automation D: Digital Clinical Pathway On-boarding

A clinical pathway is a structured multidisciplinary care plan for translating guidelines or evidence into local structures, detailing the steps in a course of treatment or care in a plan or guideline and standardising care for a specific clinical problem or procedure (Rotter et al. 2019).

A digital clinical pathway is being used in a Finnish hospital region for providing patients information early on the treatment and self-care methods of their possible condition. It is not to be mistaken with a treatment plan, which in turn is personalised for each patient depending on their background and the details of their medical condition. When a patient receives the notification for a successfully booked appointment, they are eligible for gaining access to the digital clinical pathway pertinent to their medical problem.

The process for which the automation was built was the following: When a person can be given access to their digital clinical pathway, a support ticket is raised by the healthcare professionals. The ticket is handled by the team responsible for the digital clinical pathway system, which is completely separate from the healthcare unit. Then, as the patient’s journey through the pathway progresses, additional, personalised information is added to the digital clinical pathway for the patient to view.

The automation for the process was developed because it had been noticed that not everyone gained access to the digital clinical pathway, despite their eligibility. Another reason was that it would be useful for the patients to gain access earlier to the pathway, and with everything done manually, this was not the case.

4.1.5 Automation E: Allocation of Purchase Order Invoices

In Finland, purchase order invoices are digital. Typically purchase order invoices are automatically checked against the purchase orders with no human interaction required. Occasionally, however, the details on the purchase order and its invoice counterpart cannot be matched automatically by the system. This can be due to a variety of reasons like invalid format, unexpected format, missing or mismatching information or simply a lack of an actual purchase order.

The ordering process involves first ordering a product internally from the procurement system or from the procurement team, after which a purchase order is generated and sent to the supplier. Once the supplier has delivered the goods and sent an invoice, the invoice is attempted by the system automation to be matched against a purchase order for seven days. The seven-day period exists because the purchase order can be generated manually, which means it will be manually added to the system as well. In these cases the purchase order invoice may arrive sooner than the purchase order itself has been uploaded. Once the seven-day period has passed, the invoice is moved to the manual handling queue. Then if the details are verified to be correct, the invoice is validated and can be forwarded to be paid.

The first reason for automating the manual handling part of the process with robotic process automation was that allocating the purchase order invoices was slow and required precision and a good memory. The second reason was to give the manual handling team time to focus more on the more demanding and complex invoices with the robots taking care of the simpler ones. The third reason was that the overall invoice handling time is decreased and the amount of invoices in the manual handling queue would be lower.

4.2 Subject matter expert interviews

Eight interviews were held in total. The interviews were held to gain an understanding of the impacts of the automation and to identify where some of the indirect impacts may lie. Automations C and D were the only ones where more than one expert was available for an interview. One team manager was interviewed for automation A, and the same happened for automation B. For automation C, two medical doctors were interviewed, and for automation D, one IT team manager and two medical doctors were interviewed. For automation E, one team manager was interviewed. The automations were chosen together with the healthcare organisation, and the interviewees were requested to participate based on their roles in the processes where the automations were in place. Participation to the interview was voluntary. All interviews were held between the months of February and March of 2022. The list of questions used in the interviews can be found in Appendix A.

4.2.1 Automation A

For automation A, the patient data consolidation request process, one team manager was interviewed. The automation had been running in production from the spring of 2021. The steps of the process remained largely the same. One change that was made was that the robot was given first priority for all consolidation support tickets. Manual handlers would only work on patient data consolidation if the robot indicated it was unable to complete such a task. This way it was ensured that the handlers' time was spent elsewhere as much as possible and the team was able to make the most out of the automation.

One impact of the automation was that whenever a task is passed from the robot to manual handling, it takes some time to gain an understanding into how much of the work has been done by the robot in that particular task and where the work should be continued by the human user. This was seen to be more time-consuming than handling a case from scratch. The only instance of the digital colleague showing in the daily work of the team is when a case needs to be manually handled.

The data handled in the process are the medical records of patient profiles. No preparation is done to the data before the robot handles it. About ten support tickets are raised daily, as healthcare professionals realise a patient has multiple patient profiles that should be consolidated. There had been an incident during the early days of the automation where it had not functioned, leading to a lump of 600 unhandled cases. The handling of the cases caused a strain among the team.

The amount of incident reports had at least not increased with the arrival of the automation, and problems were said to arise only if the person who raised the support ticket had made an error.

The IT benefited from the automation in the form of fewer patient data consolidation support tickets to be handled, meaning other support tickets could be prioritised, which in turn led to quicker responses to password renewal requests and other types of incidents. On the healthcare experts' side, faster patient data consolidation meant faster access to all relevant existing medical data. An anecdotal example was given in the form of recent electrocardiogram results being discovered with the consolidation, meaning the healthcare team could skip taking another, expensive one.

The automation was perceived to have been a big help, and the errorlessness was welcomed. However, the amount of time saved was only estimated to be about thirty minutes per day.

4.2.2 Automation B

For automation B, the short-term employment contract logging process, one team manager was interviewed. The automation had been running in production from the spring of 2020. Prior to the automation, the HR experts had to look at documents and forms of varying formats that contained the employment details. These were then added on the HR system one at a time. Some of the files are digital, some are hand-written, scanned or both. A standardised process for sending the employment details to the HR was missing.

To make the process more compatible with robotic process automation, an additional step was added to the process. Human users compile the data from the various files and forms into spreadsheet files, with each spreadsheet file containing the details of ten employment contracts, on a network drive which the robot accesses to gather all required information. It was stated in the interview that this procedure saved time in comparison to the previous way of doing things.

The robot was said to show in daily work a lot due to technical issues. The team has had to request multiple improvements and fixes from the automation development team. Also, the monitoring of the quality of work of the robot was deemed to have been insufficient. The issues faced had created negativity in the team towards the automation. The automation handles about 250 cases on a weekly basis, over 50% of the total amount.

Any incidents happening in the process can lead to accidental breaks between employment contracts, the wrong wage tier or wages paid for too long or a too short period of time. At the time of the interview, one of the two digital workers executing the process was offline and had caused the accumulation of unhandled employment contracts.

Finally, the automation was deemed to have improved much from its first iteration, but the journey had nevertheless been challenging. The robots had had too narrow privileges to perform all the duties they were designed to do. Information on the updated capabilities of the robots was lacking, and the robots being incapacitated due to technical issues was found to be frustrating, even more so than the downtime of the HR system itself, as the workload of the manual handlers piled up and they could not perform their other duties as plan.

4.2.3 Automation C

For automation C, the scheduling of medical doctors' appointments, two medical doctors, interviewee C1 and interviewee C2, were interviewed individually. The automation had been in place from the autumn of 2021. Interviewee C2 stated that they had joined the healthcare unit recently, and the situation in the current unit was far worse than in the previous unit, with the team being visibly exhausted and the team managers being in a tense state. Both interviewees were very satisfied with the automation, which was deemed to have been functioning "perfectly".

Some changes were made to the process to support automation better. The format of the to-be-scheduled message and its details was made more structured. No other changes were made to the process. Manual handling is only needed if the patient's phone number is missing from the information as this is needed to notify the patient of their appointment.

About 800 referrals are coming through in total, of which roughly 50% are accepted. The information in the referrals is taken from the patient data system, with only the type of visit and the healthcare unit that is visited being added to the existing information. The robot manages to handle all medical referrals, which meant the healthcare professionals' schedules could finally be checked more thoroughly and not only starting from the three months after the current date, thus leading to the schedules becoming more optimised.

Interviewee C1 pointed out that the digital worker only handles first-time appointments and thus the bottleneck in scheduling appointments has moved over to the side of booking second-time and further appointments, but not every patient needs more than a single appointment. C1 also mentioned that the average time of waiting for an appointment from the referral was made is a KPI for the healthcare unit, but that they did not know how the queuing time had changed once the automation had come to the aid of the unit, although it was perceived to have gone down somewhat.

Interviewee C2 said that it was always very frustrating to the team members when an appointment was booked for a date or time that was not actually available, for instance due to a previously existing booking. The automation does not make such mistakes, which meant that the work atmosphere had become less tense. C2 mentioned that optimising the work and the schedules of the healthcare professionals is very important, as the number of specialised practitioners is small and training a new one takes twelve years, making them rare and difficult to recruit.

4.2.4 Automation D

For automation D, the digital clinical pathway opening process, two medical doctors, interviewees D1 and D2, and an IT support team manager, interviewee D3, were interviewed individually. The automation had been in place since the autumn of 2021. This particular digital clinical pathway had not been in use prior to the existence of the automation, but interviewee D2 mentioned that some other pathways had been taken care of manually, and that it led to the pathway not being used as some of the professionals were unsure about what the digital clinical pathway concept was. Interviewee D3 also said that the IT support team had had to assist medical doctors and nurses a lot because of an inflexible CRM system, and that erroneous data had also been a common issue.

The process changed somewhat with the arrival of the automation. Because the robots are granting access to the digital clinical pathways for patients, nurses only need to add personalised, more detailed information to the existing pathways. The robot checks all appointments that are in up to three weeks from the current date to ensure as many patients as possible could access their pathway before their appointment. Previously this was not possible due to a lack of resources.

Originally the automation had been functioning very slowly, four times slower than a human user. Some of the functionalities of the automation were also more limited than expected, which led to additional process definition work. The issues had since been corrected by the automation development team and the automation had been able to reach a speed of 1-20 seconds per handled case, with fewer exception cases as well.

On the IT side, the amount of support tickets requesting assistance for the system where access to digital clinical pathways was granted had gone down, as the medical doctors and nurses no longer needed to concern themselves with the task. On the healthcare unit side, patients had been noticeably more active in using their pathways; this perception was based on the increased amounts of self-care application diary updates done and well-being questionnaires being completed. Although interviewee D1 mentioned that no data was available on the effect the digital clinical pathways have on the well-being of the patient, interviewee D3 pointed out that the sooner the access to the pathway is granted, the sooner the patient has the opportunity to apply the self-care methods mentioned there to their condition.

4.2.5 Automation E

For automation E, the allocation of purchase order invoices process, one team manager was interviewed. The automation had been in production since the autumn of 2021. The interviewee stated that the automation project had been on-going for years, and that both the process definitions and the systems had gone through changes multiple times during the project.

Some changes had to be made so that automation could be utilised in the process without disrupting the routines of the team. The robot executes the process differently from the manual handling team. Because of the invoice handling application, there was no visual cue for the robot to see whether any user is currently working on a given invoice. The manual handling team could always discuss with each other to ensure that no two users were handling the same invoice, but this was not a feasible approach for their digital colleague. For this reason, instead of gaining a tireless worker handling invoices around the clock, the automation was restricted to be handling invoices outside of business hours to prevent any form of work duplication.

Occasionally the virtual colleague is unable to allocate a purchase order invoice. When this happens, it passes the invoice to manual handling, while also indicating why it was unable to process the invoice. This makes it easier and faster than previously for the human users to process the invoice, as they can focus immediately on the erroneous part and know that the rest was deemed to be fine by the automation. The list of invoices that could not be handled by the automation is sent out to the manual handlers every day at six in the morning.

In total 10 000 invoices are being handled every month, of which 6000 are taken care of by automatic invoice routing. The remainder, i.e. 4000 invoices, are then handled by the team and their digital colleague. The number of invoices handled by RPA had been low, with the automation only handling 112 invoices. However, since the robot attempts to handle all 4000 by itself, it is able to gather a report of the most common reasons for unsuccessful handling, which the team has been able to use to analyse how the process could be improved. The reasons for unsuccessful handling are nearly always to do with the format or contents of the incoming invoice, and the reports indicate clearly which suppliers are causing the biggest strain on the team with their non-standard invoices. The interviewee stated that the robot could surely handle a much larger portion of the invoices, but it would require some process engineering and automation redevelopment.

The amounts of invoices processed late is being measured in the unit, and with the help of the automation, that number has gotten lower. As the intention was, the team has also been able to focus on other kinds of invoices instead of the ones now handled by the robot.

Finally, the interviewee mentioned that there have been occasions when it has been unclear why the robot has not marked an invoice as erroneous, and that the whole automation development process has been an eye-opening and painful but enjoyable experience and they have more ideas for where automation could be used in the team.

5. Conclusions and future research ideas

This section is about the conclusions that were drawn based on the automations and the interviews. There are also three subsections: process improvements, identifying indirect impacts and future research ideas. The first subsection presents suggestions on how to measure indirect impacts in the processes where **Automations A-E** are in place, the second subsection is about how to identify potential places for indirect impacts in processes and the third one lists some ideas on how this study could be improved and what could be researched next.

Based on the eight interviews and the five automations it can be said that the process or task tends to change at least somewhat when it is automated. Sometimes the process is modified to suit automation better, even if it leads to new, additional steps in the process. Sometimes the changes are only relating to how the remainder of the cases are handled after they have gone through the processing of the digital workers. The people who had previously been handling all of the work cases had their work change in at least two ways. Firstly, they received a digital colleague, who was handling cases for them to the best of its ability, improving human-robot collaboration. Secondly, the teams are much less focusing on the automated tasks, as they only need to handle the leftover cases. It became clear that the automations have allowed the focus of the efforts of the teams to move more to other tasks. Although many studies state that people can be given whole new tasks, based on the interviews it seems that in the studied cases each team was purely focusing more on other tasks for which they were already responsible. Of course, new work does not just appear out of nowhere, so some restructuring of responsibilities would likely be needed before any of the teams could start taking on completely new work tasks.

Due to a lack of transparency between the unit for whom a task was automated and the end users, like patients or healthcare professionals, it was very difficult to determine how the end users benefit from the automation. The same can be said about how the healthcare organisation itself benefits from the process automations; only the direct benefits were identifiable, with the rest of the impacts being very vague. With more monitoring in place, determining the impacts would have been much easier.

Nevertheless, the indirect impacts that could be identified based on the interviews have the potential to be very meaningful. One example is the ability to save time and money with patient data consolidation by being able to forgo an MRI or blood test when it transpires one has just recently been done. However, with some process improvements, quantifying these impacts would be made possible.

5.1 Process improvements

To be able to measure indirect impacts better, some changes are proposed to each of the five processes where automations were in place. In the patient data consolidation process the role of **Automation A** is in a support process which exists to aid healthcare professionals. Diagram 2 presents the proposed changes to the process. The changes are relating to the end part of the support process, where after the automation has consolidated the data and closed the support ticket, a form is sent to the person who originally raised the ticket. The form should have a few short questions to help determine if the data consolidation, for instance, led to the healthcare unit to change the planned treatment method or the previously planned tests due to the revealed information. These forms are then analysed by the automation centre of excellence on a regular basis, e.g. every three months, to measure the impact of the data consolidation periodically. This will also increase the flow of information between the healthcare units, the IT and the automation centre of excellence.

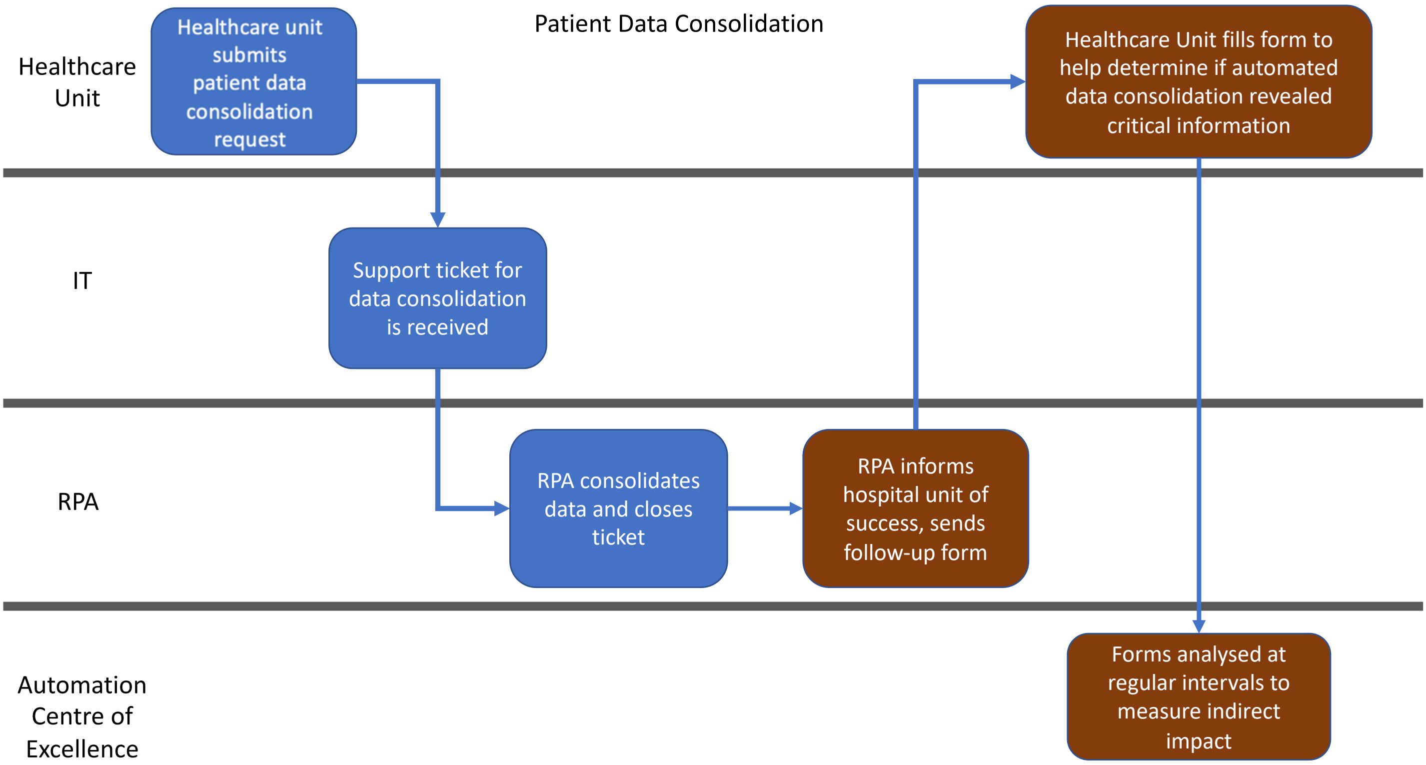

Diagram 2. A suggested workflow for the patient data consolidation process to help in measuring some of the indirect impacts. Steps in brown are new to the process.

For **Automation B**, based on the interview, a way to measure some of the indirect impacts would be to monitor the number of contract-related errors made and how much time is spent per error. Analysing the average number of errors before the automation existed and after will give an estimate on how much time is saved due to the number of human errors being fewer. With fewer errors come also fewer paycheck-related issues, which means the cash flow of the health care organisation becomes more stable. The magnitude of this effect, however, is likely to be non-significant for the organisation. Diagram 3 presents the proposed, updated workflow.

Also, as mentioned by the interviewee, standardising the employment detail submission form would be a great improvement. This would allow for the removal of manual handling from between the employment detail forms and documents and the robot.

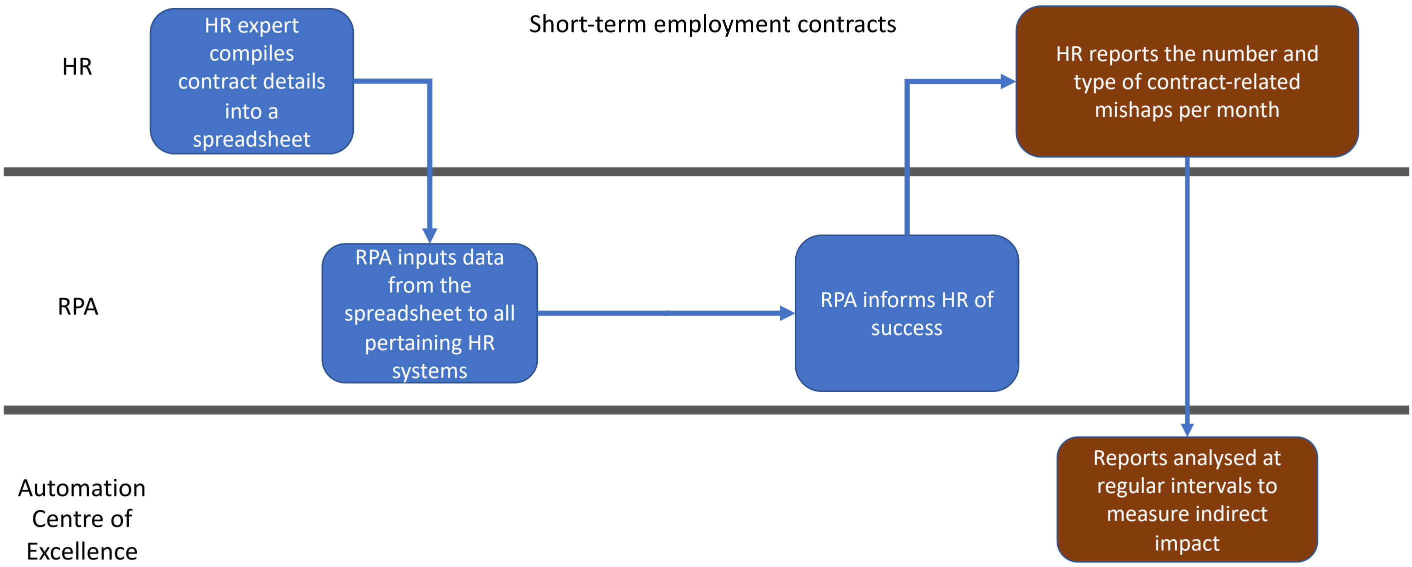

Diagram 3. A suggested workflow for the short-term employment contract logging process to help in measuring some of the indirect impacts. Steps in brown are new to the process.

For **Automation C**, comparing the average queueing time, employee satisfaction and patient satisfaction before and after the automation was implemented seem to be the most measurable indirect impacts. Diagram 4 presents the suggested workflow for increasing process transparency and therefore making indirect impacts more visible.

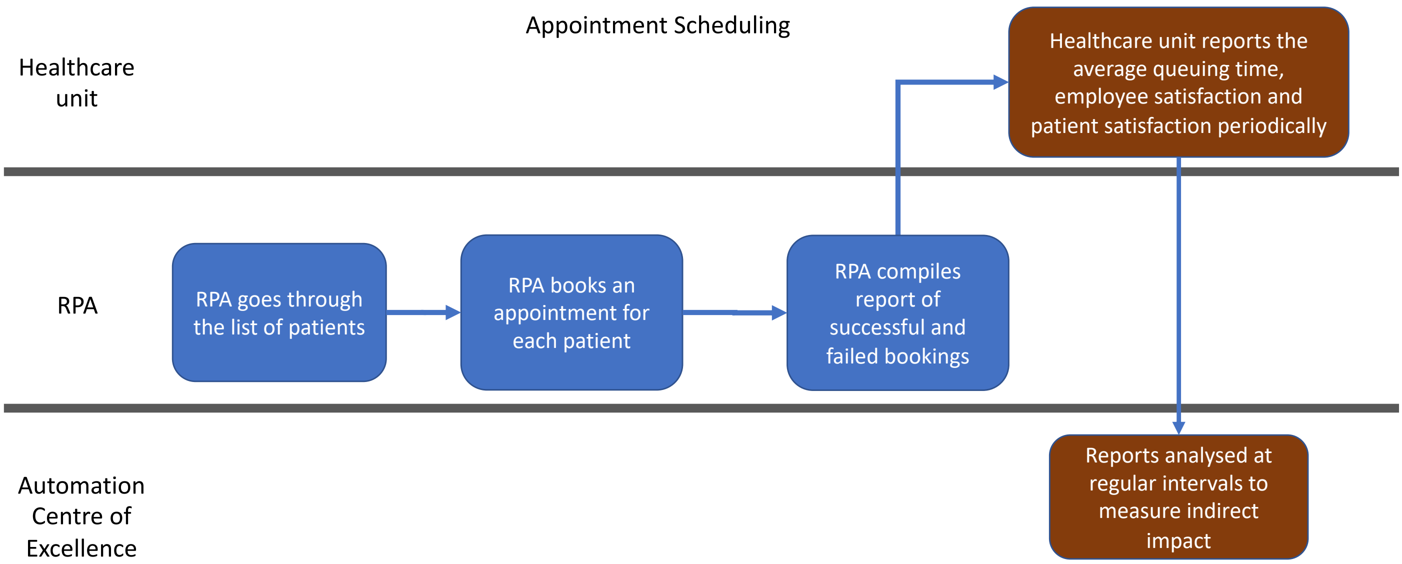

Diagram 4. A suggested workflow for the appointment scheduling process to help in measuring some of the indirect impacts. Steps in brown are new to the process.

In the interviews for **Automation D**, it was already mentioned that it appeared that patients had started using the digital clinical pathway sooner than they had prior to the automation implementation. Measuring this, however, should still be done. One way of doing that is to develop the automation further. Having the automation check if the people for whom the pathway was opened had visited it and remind them to do so if they have not already would bring two benefits: First, the automation can create a report containing each person who had taken it to use and who had not, and second, automated reminders save the time of the healthcare staff and leads to more patients to have the opportunity to start applying self-care methods sooner than before. The reports generated by the automation should then be periodically analysed by the healthcare unit and the automation centre of excellence. Diagram 5 presents the suggested workflow for measuring the impact of granting early access to the digital clinical pathway.

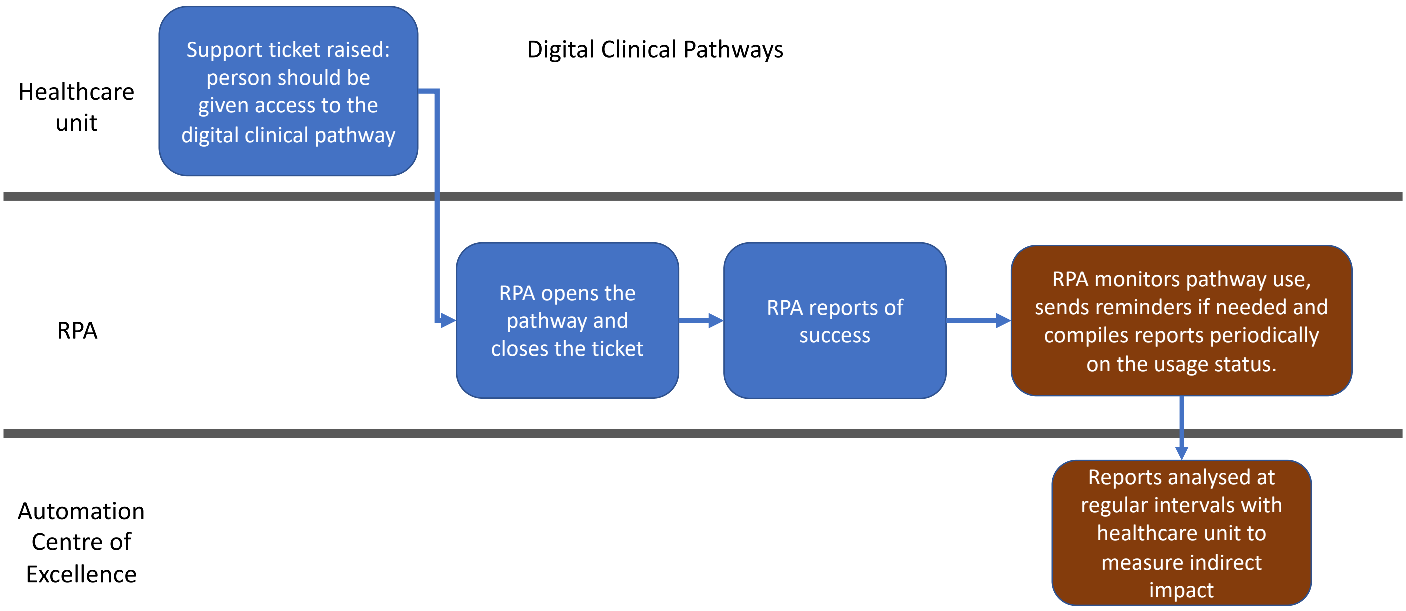

Diagram 5. A suggested workflow for the digital clinical pathway process to help in measuring some of the indirect impacts. Steps in brown are new to the process.

For **Automation E**, based on the interview, the indirect impacts seem small. The number of invoices which were paid after the due date could be measured. Employee satisfaction was also seemingly affected by the automation, as there were many negative feelings towards the robot due to its shortcomings. From a communications perspective, digital transformation is almost never dealt with in much detail. Developments in recent decades have shown that early and professional communication can significantly increase the acceptance of technologies and their consequences at organisations (Klewes et al. 2017). Improving the automation and communicating about the automation improvements and expectations of the team more openly, as Klewes (2017) points out, would be some ways to turn the negative indirect impacts into more positive ones, whilst also increasing the level of collaboration between the units. Therefore, the suggested process improvements are instead to do with the automation development process rather than the particular business process where **Automation E** resides. Diagram 6 presents the suggested workflow. Continuous improvement is key, and with that must come continuous communication.

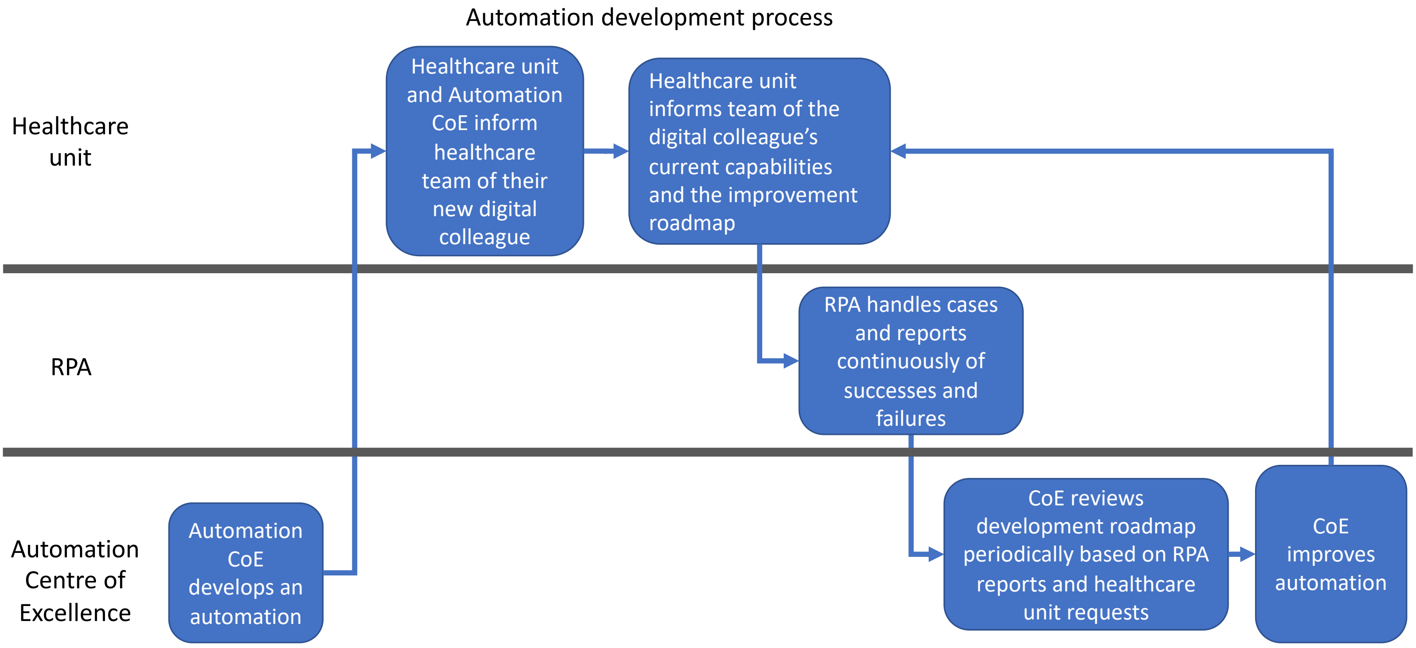

Diagram 6. A suggested workflow for the automation development process, emphasising continuous improvement and open communication.

5.2 Identifying indirect impacts

Automation A came to be because the IT wanted to have a robotic process automation help the team handle some of the support tickets relating to a support process in which patient data is consolidated. In a case like this, to get started with understanding where the indirect impacts might lie, it is important to ask why does the support process exist and who is the beneficiary of the process in the organisation. Then the benefiting party can be contacted and interviewed to determine the role and importance of the support process in their routines. It is important to be open about the possibilities of what the automation can and cannot do to manage the expectations and fears of those involved.

This method can be used even if the automatable task or process in question is not a support process. Diagram 7 presents a suggested workflow for the automation assessment and development process with impact monitoring. Once a unit, be it healthcare, HR, IT, finance or other, gets an idea for automation, it is presented to the automation centre of excellence, which is responsible for the automation delivery in the organisation.

The idea should already have some basic calculations of the direct impacts the automation would have, so that the CoE can has an idea of the magnitude of impact of the automation. After the business case has been discussed by the CoE and the unit, a workshop for identifying indirect impacts is held. Although identifying all of the indirect impacts will be very unlikely, the goal is to find some that can be monitored, for instance ones that affect the KPIs of the unit. A way to get started with the impact mapping is to determine what is the plan for the time that will be saved by the automation and understand how the reallocation of the freed-up time will show in the performance of the unit. In the case of a support process, the unit served by the support process should be listed and stakeholders from at least some of those units should be present in the workshop to understand how they will be impacted. The workshop will also enhance the communication between the CoE and the units.

Once a combined picture of the direct and indirect impacts has been formed, the automation suggestion is placed in the prioritised pipeline of the CoE. Later, when its turn to be developed is, an impact monitoring planning discussion is held between the unit and the CoE. The meaning of this meeting is to formulate a plan to be able to tangibly measure and monitor how the performances in the unit are affected by the existence of the automation. The level, method and frequency of reporting is also agreed upon in the meeting.

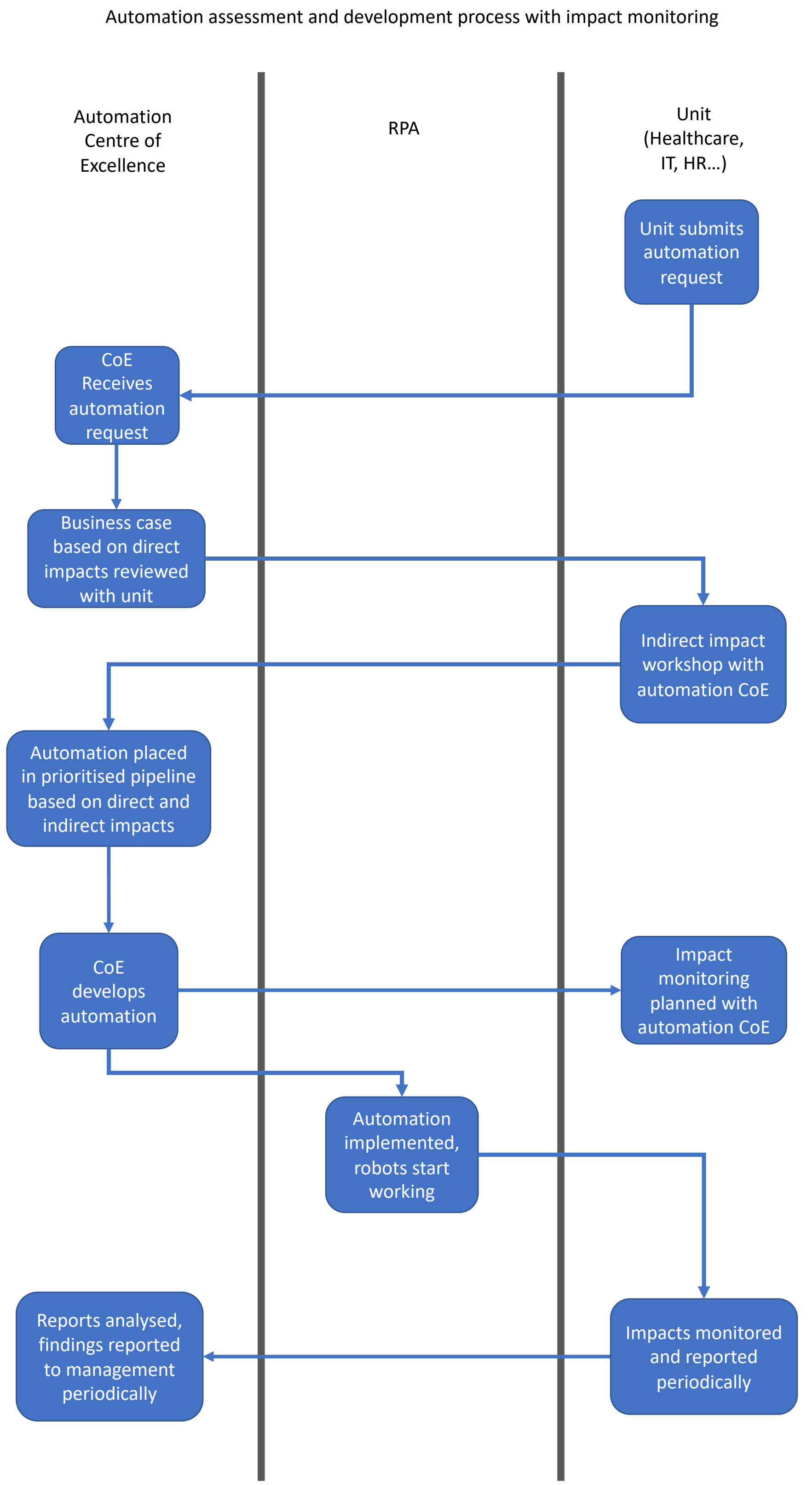

Diagram 7. A suggested workflow for the automation development process that helps in identifying and measuring indirect impacts.

Once the automation is implemented and the digital workers are executing the process, impact monitoring begins and the results are reported to the automation centre of excellence as agreed. The CoE will then analyse the reports and report their findings to the management. This reporting procedure will increase the communication between the automation CoE and the management and increase the level of invested interest in robotic process automation in the organisation.The findings of Tursunbayeva, Bunduchi & Pagliari (2020) show that the benefits realisation process in nationwide IT projects can take time and while some benefits will be realised, others may not be. Whilst a single robotic process automation project cannot be compared with a nationwide IT project, quantifying the realised benefits and finding them can also be difficult in robotic process automation projects, especially if the indirect impacts have not been identified at all.

Understanding the KPIs of the benefiting party and how the process aids the unit or team in reaching those is important, as this way it becomes clearer to understand where to look for the positive changes when the automation begins to be used in the process. Once the automation has run for a while, e.g., three months, some change in the KPIs might already be visible. It is also important to keep monitoring them and keep the dialogue between the automation centre of excellence and the unit going. This way discussions can be held on how automations could help further in improving performance or in easing the workload.

By cross-referencing the already developed robotic process automations against the mapped core processes of Finnish healthcare (Vuokko et al. 2011), new perspectives can be found about the kind of role RPA has in the end-to-end process, as well as new ideas on where to potentially utilise RPA next. Also, by making the relation between the single-point RPA solutions and core processes clearer, people higher up in the organisation will have an increased interest on the capabilities of RPA as an enabler of process efficiency, which will improve the level of cooperation between the healthcare units and the CoE. The people in the automation centre of excellence are not likely to be experts in the details of core processes, and thus having a direct communication channel between the stakeholders becomes vital for the healthcare organisation to be able to reap bigger benefits from robotic process automation and other automation technologies. This way the complete end-to-end process becomes easier to analyse and the collaboration between the automation experts, the IT and the healthcare experts allows the organisation to create a long-term plan for improving the performance of care processes with automation technologies. The importance of this is emphasised by the average age of Finns rising (Terveyskylä.fi, 2019), as healthcare organisations are facing pressure to cater to more people with resources that cannot be scaled at the same speed. Optimising the existing ways of working with the aid of technology becomes then very important.

A deeper dive into where RPA could be utilised next in the context of a core healthcare process could also be made with the application of process mining. Process mining tools are excellent complements to RPA tools in the analysis phase, and also during the later governance and continuous improvement of the processes. A focused process simulation is often helpful to properly understand the current execution effort, cycle times and major bottlenecks. This simulation can then be used to demonstrate the impact of using RPA to automate certain steps in the process, highlighting the overall impact on the process performance. RPA can be made to be a part of a wider digital transformation and how a process should be engineered first to be more suitable for improvement through contemporary technologies and what kind of monitoring and governance should exist to ensure the change in the process is as successful as planned. The study approaches the topic of RPA from the perspective of the business process, presenting the parts of an end-to-end business process where the application of robotic process automation brings the most benefits. Having RPA as a cog in a broader digital transformation program with monitoring and governance in place also enables indirect effects to become more visible for the organisation (Kirchmer & Franz 2019).

The end cause for an RPA development project or upgrading to a new CRM is to make a task or process more efficient. Therefore, being able to monitor the throughput of the processes to measure performance should be a priority. A technology for doing that, as well as identifying bottlenecks within the processes, is business process management (BPM). BPM can be used as a holistic software platform that encompasses a wide range of functionalities such as process design, analytics, and monitoring, and the software is often used to orchestrate end-to-end processes, and to manage humans, robots, and system interactions in the process (Ivancic, Vuksic, Vugec, 2019). Business process management could thus be used to create monitoring and measuring for processes that extend across teams and units in the healthcare organisation and provides valuable information that can be then leveraged to identify where automation or other kind of process enhancement should next take place.

5.3 Future research ideas

Interviewing more people in different roles and units would have likely helped to identify more indirect impacts. Originally it was planned to interview experts both before and after a digital worker has been added to their teams, but the timelines between performing this study and the automation delivery roadmap of the healthcare organisation did not match sufficiently for it to have been possible. Interviewing multiple teams and units linked to a single automation was intended, but time constraints led to instead broadening the study into inspecting multiple automations in a lighter manner instead of deep diving into a single one. Diagram 8 presents the planned method. A and B present the people and tasks before and after the point in the process that was automated, respectively. This thinking could then have been extended to A-1 and B+1 and so on, i.e., to go further up and down the end-to-end process flow to see how far the indirect impacts reached in any significant way. One identified challenge here was how to be able to ascertain that, especially the further in the process the inspection is taken, the impacts in performance can be verified to be because of the automation and not some other change, perhaps another automation, elsewhere in the process. Another acknowledged risk was that the changes in the time allocation for any of the experts in the vicinity of the automation would not have been accurately and actively monitored.

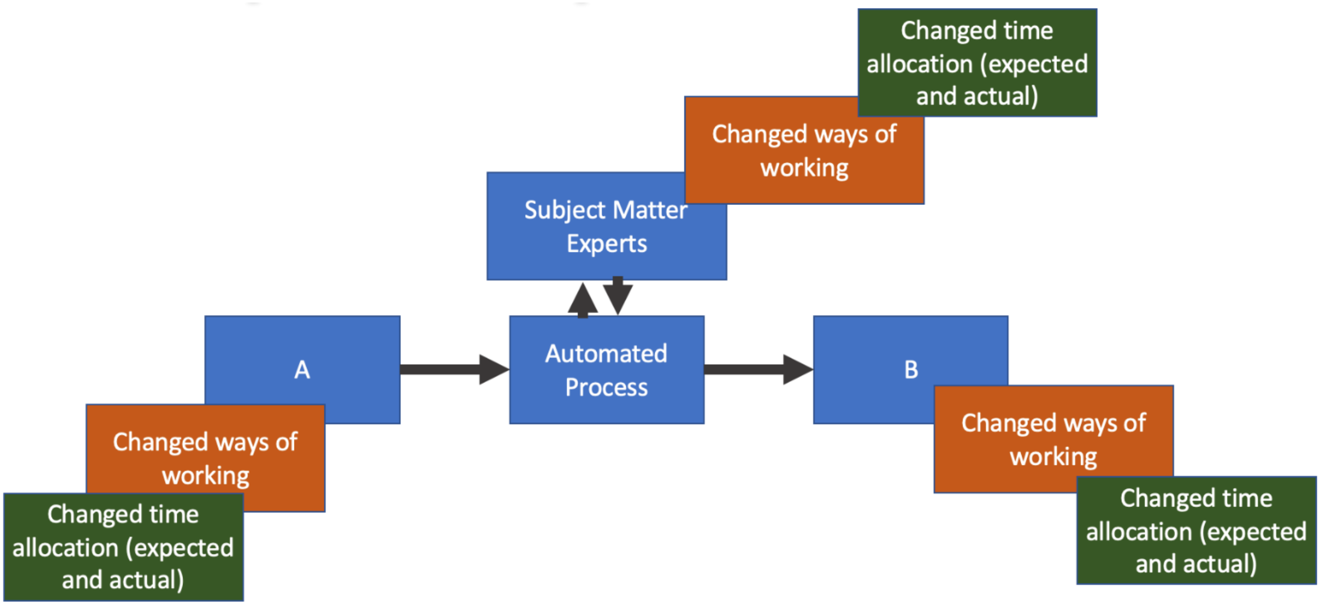

Diagram 8. The early idea behind the method for measuring the indirect impacts of a single process automation in the healthcare organisation thoroughly.

Performing another study but from the perspective of the core processes could also bring more accurate results and reveal bigger impacts. A way to measure the impact of an automation could then be, for instance, to measure the effectiveness and importance of a support process for a core process to understand the benefits it brings, and then calculate how much more effective the support process becomes or has become with automation. From there it could be estimated how much more benefit is generated for the core process. However, this would require far more extensive participation from the targeted organisation and more extensive interviews, so that their viewpoints could be understood in adequate detail. Another study relating to that could then be one where process improvements and monitoring have been applied, and their realised impacts on the organisation are analysed. In other words, being able to gather data about the performance of units before and after an automation or another kind of process change has been implemented would make it much easier to analyse the actual impacts, and would most certainly bring the most tangible results for this type of study.

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Appendix 1: Interview Questions

"For how long has the robot been working for you?"

"How was the work task performed before its automation?"

"How did performing the work task change once the automation was developed?"

"How does the robot show in your daily work nowadays?"

"What kind of data does the robot process?"

"Who or what prepares the data for the robot? (Application/Team/Unit)"

"What happens to the data once the robot is done processing it? Who benefits from the processed data?"

"Have there been more or fewer support requests regarding the work the robot is now doing?"

"If you were involved in the automation development project, what was that like?"

"Have other units or colleagues made their interest known regarding robotic process automation?"

"Are you aware of any other robotic process automations that your healthcare organisation has up and running?"