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Dr. Robot or Dr. Efficiency? The Impact of Robotic Process Automation on Jobs in Healthcare

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Keywords

Robotic Process Automation, Intelligent Automation, Socio-Technical Systems Theory, Healthcare, Palonyi's Paradox

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Introduction:

For centuries, public fear of automation technology replacing jobs has permeated through society. The anxiety around job replacement began during the Industrial Revolution with the Luddite movement in destroying textile machinery and has evolved over time to fears of hardware and software robots replacing workers in a multitude of occupations and skill levels. Technological innovation brings both bounty, an increase in the volume, variety, and quality of goods and services, as well as spread – the differences among people in economic success.[1] While research has examined both bounty and spread brought by technology over time, very little research has explored the impact of Robotic Process Automation (RPA) on labor supply. It is thus necessary to analyze the improvements in quality of work and care while also unpacking the gaps in the economic success that have the potential to occur. This study explores how Robotic Process Automation (RPA) and Intelligent Automation (IA) will impact jobs within the healthcare sector. Specifically, the study will explore how this specific class of technology will add value to people across functions, the benefits and drawbacks of implementing this technology in healthcare systems, and how the tasks people perform will change.

Extensive literature has been published on how technology, broadly speaking, will remove and change jobs. Existing research has largely adopted a macro focus both in terms of the independent variable, the technology, as well as the dependent variable, the jobs being changed. However, it is overly simplistic to make sweeping assumptions about the future of the labor force by grouping many different types of technologies as one. For example, technology such as GPT-3, an NLP model that uses deep learning to produce human-like text will have a very different impact on the labor force than a

[1] Brynjolfsson, McAfee, *Second Machine Age.*

hardware robot used in Amazon warehouses to expedite shipping. Regarding the dependent variable, jobs, different industries have adopted new technologies at different rates, depending on the regulatory landscape, the number of stakeholders involved, sales cycles, existing infrastructure and the complexity of their ecosystems. For instance, the logistics industry might adopt and use a given technology in different propensities than the education system. For these reasons, this study will hone in on a specific category of technology and a specific industry.

The healthcare industry is poised to benefit greatly from automation technology because of the $1.1 trillion in administrative spending that occurs every year.[2] According to Pranay Kapadia, the CEO of Notable, a healthcare process automation company, the healthcare industry requires eight times as many resources per $1 billion of revenue as any other industry in the world.[3] Although one might not intuitively think of RPA when it comes to healthcare given the human-centric nature of the industry, the healthcare industry is one of the fastest industries to adopt the technology. This is because there is a large volume of data and manual, rule-oriented processes that RPA can handle well. Cumbersome processes require valuable human capital and slow down operations. This is particularly topical in light of the COVID-19 pandemic, which had produced tremendous strain on the healthcare system and has made resource allocation top of mind for hospitals.[4] Delays in diagnoses as a result of COVID-19 caused and will continue to cause backlog and strain on the healthcare system, highlighting the need for doctors and nurses to spend more time with patients than on administrative, manual duties. According to a report from 2021, 92% of clinicians spend time on administrative tasks that culminate

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[2] *National Health Spending in 2020 Increases Due to Impact of COVID-19 Pandemic | CMS.*

[3] Ingrid Lunden, *Notable, which makes RPA-based tools to speed up healthcare admin, raises 100M at 600M valuation.*

[4] *Nusing Healthcare Back to Health White Paper | UiPath.*

in burnout and 64% indicate that there are not enough staff to handle the large troves of patient data.[5] Healthcare RPA and IA companies promise to increase the ROI and output per hour of work for healthcare system clinicians and staff so that there is heightened productivity, fewer errors and less burnout. Identifying tools that will make clinicians' work less stressful is particularly crucial given the "Great Resignation". Throughout the COVID-19 pandemic, nearly one in five health care workers quit their job as a result of burnout. [6] Rick Pollack, the CEO of the American Hospital Association (AMA) reported that by 2026 there will be a shortage of 3.2 million healthcare workers.[7] A key source of this burnout is that humans are expected to act as routers because healthcare information systems oftentimes lack interoperability. In other words, nurses and staff are expected to extract, transform and load data manually.

RPA and IA, which will be described in depth in section two, are useful technologies to study when considering the spectrum of automation technologies because they handle relatively simple tasks and have the potential to save time in 60-70% of enterprise processes.[8] Because intelligent chatbots and artificial intelligence deal with more complex tasks, involving natural language, reasoning and judgment, they impact a smaller number of processes than RPA in healthcare. At this point, RPA has a much more established market than Intelligent Automation. That being said, RPA vendors are increasingly layering in artificial intelligence capabilities that will make them function more like IA systems in the near future. The global market for RPA is expected to exceed $20 billion in the next

[5] *Internet of Healthcare Report, Findings Summary Q4.*
[6] *Nearly 1 in 5 Health Care Workers Have Quit Their Jobs During the Pandemic.*
[7] *Healthcare second largest sector hit by Great Resignation.*
[8] Schwartz, *Creating a Digital Workforce: Implementing Intelligent Automation in Hospital Operations.*

decade, with a CAGR of 30% over the next seven to eight years.[9] Within the RPA market, there is an increasing shift from horizontal to verticalized solutions that include more specialized features for specific industries. According to a McKinsey report, differences in tasks create large variation in potential for automation across industries.[10]

The methodology for examining the impact of RPA on jobs in healthcare systems involves a comparative analysis of five major healthcare systems that plan to adopt or have already adopted RPA. These case studies will involve doing research on the history of the specific healthcare systems and interviewing a number of stakeholders involved with RPA implementation, including Chief Medical Information Officers (CMIOs) and Chief Digital Officers (CDOs) of healthcare systems including Penn Medicine, Yale Medicine, Houston Methodist, Intermountain Healthcare, and Kansas North City Hospital, operators at healthcare automation companies such as Olive and Notable and healthcare and process automation investors. Analysis of the decision processes hospitals make around selecting and implementing RPA and IA solutions will be useful to both healthcare operators involved with digital transformation in hospitals and healthcare investors. The research will also be useful for acadmic researchers interested in the impact of automation on work, as the study will shine light on how organizational considerations impact a company or healthcare system's decision to automate certain processes. Before delving into the comparative analysis of other, related aspects of the impact of automation on work, it is important to highlight the existing literature that has been written on the topic.

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[9] *Robotic Process Automation Market to Hit USD 23.9 Bn by 2030.*

[10] *Intelligent process automation: The engine at the core of the next-generation operating model | McKinsey.*

Review of Literature

Automation Literature

Several categories of literature have been written on the topic of automation in the workplace. The first type of literature studies how automation broadly speaking will have an impact on the macro characteristics of the labor force. Some studies focus on the impact on the health of the overall economy and consumption patterns, while others categorize the number of jobs available by function. Samantha Cinco discusses in her 2021 paper how automation improves the global GDP by 1.4% annually. She specifically argues that digitization has the potential to expand the production possibilities frontier and increase the quantity of goods produced given constraints on labor, capital and land. In the same way that saws and levers have helped workers do faster work by acting as extensions of arms, digital technology acts as an extension of the brain. Digitization thus leads to faster production times and reduced prices.[11] Another notable study that quantifies the impact of automation on the quantity of jobs available is by Carl Frey and Richard Osborne, who estimate the probability of computerization for 702 occupations and explore the implications for the US labor market outcomes, wages, and education attainment. The key finding of the paper that sparked extensive discussion amongst scholars was that 47% of jobs were at risk of computerization and that jobs with higher wages and education levels were associated with lower probabilities of computerization.[12] Discussion also ensued about whether the results adequately considered how the

[11]Samantha Cinco, *Companion or Substituion? Automation andd Digitisation in the Workplace.*
[12] Frey and Osborne, *The Future of Employment: How Susceptible Are Jobs to Computerisation?*

use of the new technologies were shaped was shaped by the particularities of the contexts in which they were implemented. Other resarchers expand on these studies by examining specific instances in which automation replaced jobs. Bessen's 2015 paper highlights how the introduction of the Automated Teller Machine (ATM) prompted fears of mass job replacement among bank tellers, but their introduction instead led to the quadrupling of teller jobs between 1995 to 2010. Because ATMs replaced tellers at individual branches, they reduced the operating costs per bank branch. This resulted in banks increasing the number of urban branches by 40% and increasing the number of personnel they hired for personnel required for "relationship baking". [13]

The second category of research explores acadmic theories relating to the nature of work and how jobs are transformed. David Autor's paper in 2014 discusses Polanyi's Paradox, the idea that we know more than we can verbalize about certain processes. The paradox highlights that our tacit, subliminal understanding of the world is often greater than our explicit understanding. This means that we might know how to conduct a certain task or process, but we do not typically codify that process into a series of rules. For example, our knowledge of our own bodies, how we move and the different types of feelings we experience exceeds our knowledge of physiology and neuroscience. In the same paper, Autor also argues that journalists and expert commentators overstate the extent to which machines will substitute human labor and ignore complementarities that have the potential to increase the standard of living and demand for skilled labor. He draws attention to the "lump of labor fallacy," which suggests that an increase in labor productivity reduces employment because there is a finite amount of work to do. Autor also highlights the distinction between automating individual tasks

[13] Bessen, *How Computer Automation Affects Occupations: Technology, Jobs and Skills.*

involved with a particular job occupation and automating the job in its entirety. While it is increasingly common for individual tasks required in a particular workflow to be automated, for automation to replace a complete job, multiple tasks must be automated.[14]

In addition to literature on academic theory relating to work, researchers also study the specific conditions in which new jobs are likely to be created, transformed or replaced. In their book, *The Second Machine Age,* Eric Brynjolfson and Andrew McAffee explore how as computers become more powerful, companies will have less need for certain types of workers, and that there will be a shifting demand to new occupations.[15] Software applications are non-rival resources that can also be replicated at almost no marginal cost, so it is attractive for companies and employees to digitize as much as possible. The authors argue that information processing tasks that cannot be translated to rules are the least likely to be automated. In their book, a *New Division of Labor,* Levy and Murnane argue that driving cars fell in the category of tasks that could not be automated because it involved taking in information from multiple senses, in which new, unpredictable scenarios constantly arise. This prediction was proven incorrect with the advent of self-driving cars. Levy and Murnane also predicted that complex communication was less likely to be computerized, yet Apple invented Siri.[16] Brynjolfson and McAffee provide a helpful framework for analyzing jobs most at risk of automation. The authors argue that all routine tasks are declining, regardless of whether they are more cognitive or manual, whereas non-routine jobs, both cognitive and manual, are more likely to remain conducted by humans.

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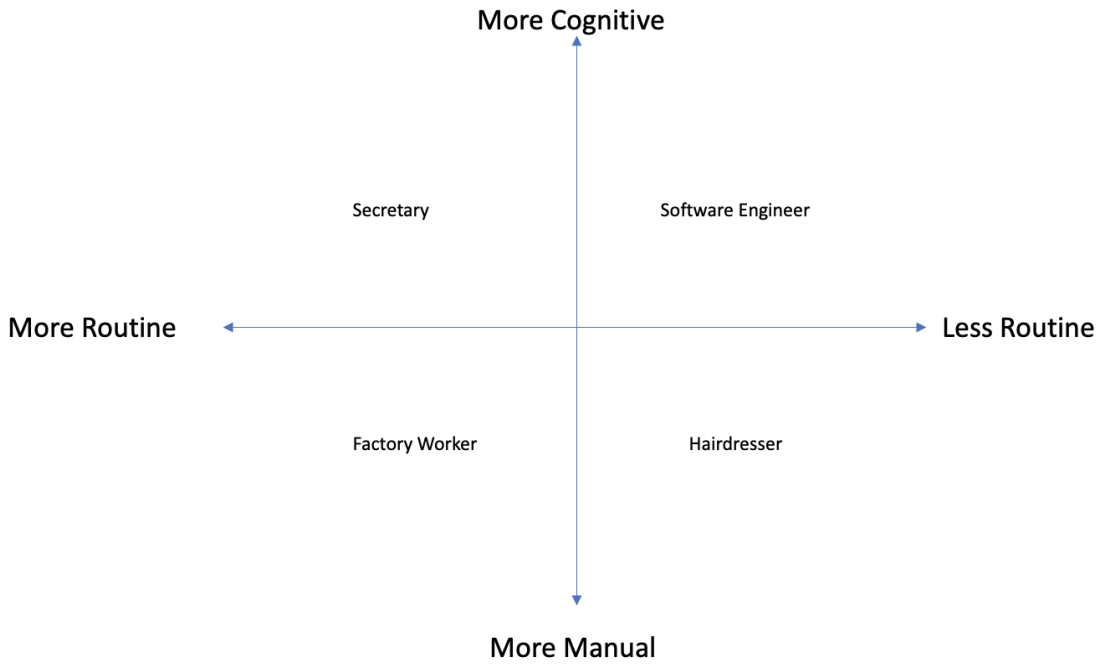
[14] Autor, *Polanyi's Paradox and the Shape of Employment Growth.*
[15] Brynjolfson and McAffee, *The Second Machine Age.*
[16] Levy and Murnane, *A New Division of Labor.*



Skill-biased technical change involves changes in production technology favoring skilled labor more so than unskilled labor, thus increasing the demand for skilled labor. Violante suggests that new information technologies complement skilled labor, thus drawing attention to technological change as a contributing factor to income disparities. In this sense, computers are not always a source of job loss; instead, organizational conditions play a material role in determining whether technology serves as a complement or substitute. The growth of occupations that involve computers requires reskilling for technical skills.[17] Shestakofsky contributes to the discussion by highlighting two forms of software complementarity: computational labor that supports software algorithms and emotional labor that

[17] Violante, *Skill-Biased Technical Change.*

helps users adapt to new software systems. These complementarities represent new ways that humans and computers can interact that do not involve humans losing their jobs. Shestakofsky also describes the differences between discontinuity and continuity theorists. Discontinuity theorists view innovations in machine learning and artificial intelligence as epochal moments in which the technology can now train computers to do things that previously required tacit knowledge and human cognition. Continuity theorists, on the other hand, do not think machines are substitutes for tacit knowledge and believe that people must look beyond substitution to understand the relationship between technology and employment. Humans are necessary components in the implementation of artificial intelligence and machine learning algorithms.[18]

Lastly, researchers have also examined how these outcomes compare relative to public perception of the impact of automation. Matias Dodel and Mesch examine the correlates of what shapes a person's perception of automation on jobs. The researchers found that individuals with more manual, physical jobs were more likely to have negative perceptions about technology, whereas people whose jobs involved more data analysis and managerial decisions were more likely to have more positive views. Age was also a defining correlate of perception of automation. Older workers with lower levels of education tended to view automation with more apprehension. [19] Taken together, existing literature on the impact of automation on work analyzes macro changes, academic theories and generalities across many functions and industries. Few, if any, papers "go into the weeds" and study the task-specific parts of a job are altered in a particular industry.

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[18]Shestakofsky, *Working Algorithms: Software Automation and the Future of Work.*
[19] Dodel andd Mesch, *Perceptions about the Impact of Automation in the Workplace.*

Healthcare Literature:

With regard to literature on healthcare technology, researchers have published work classifying the different types of innovation as well as how they impact patient care. Researchers have begun to explore how the implementation of health tech could impact inequality in terms of jobs available, but literature has not explored reskilling or how jobs are transformed. In his paper on the impact of new technology on the healthcare workforce, Ari Bronsoler categorizes some of the major information and communication technologies (ICT) in healthcare systems in the past several decades, as well as the patterns around what factors drive adoption. Electronic Health Records (EHRs) digitize the medical chart and include data such as lab values, images, and progress notes. Healthcare analytics and machine learning algorithms can accurately collect measurements and predict which patients are susceptible to complications or side effects. Although improvements in health information technology have proven to improve patient outcomes, adoption remains relatively slow due to the complexity, cost, and patient privacy issues with new technologies. Additionally, changing the routines of clinicians and other healthcare employees' and educating them on new, complex systems can be onerous in a fast-paced, personnel-constrained setting. Bronsoler discusses the disconnect between the perception that health ICT exacerbates inequality, job loss and reality that there is no strong evidence for this phenomenon. While the skills required to perform a particular task might evolve as a result of information technology adoption, there is no strong evidence that ICT has a causal effect on inequality. This literature provides

a helpful starting place for understanding the high level impact of different types of technology, but it does not go into specifics on how individual tasks change.[20]

The COVID-19 pandemic has served as a catalyst for the adoption of both disruptive and sustaining innovations in healthcare. Improvements in video conferencing software, secure platforms for SMS, and remote monitoring devices have helped usher in new modes of hybrid online and offline care that have helped better serve overlooked populations. New startups are leveraging technology focused on improving the omnichannel patient experience and helping established healthcare systems implement hybrid care delivery models. There is also increased attention on companies delivering the technological infrastructure to deliver care virtually, help telemedicine companies go to market as fast as possible, and connect with other applications and API platforms. Hemant Taneja, founder of Livongo and investor at General Catalyst, Jefferson Health CEO Stephen Klasko, and writer Kevin Maney argue in their manifesto *UnHealthcare* in favor of a new model of care delivery called Health Assurance, that leverages data, artificial intelligence, and the cloud to bend the cost curve of care and improve health outcomes. This model focuses on interoperability, improving the ability for EHRs and disparate information systems to speak with one another, and applied health signals, which utilizes technology to empower patients to manage their condition from home.[21] This literature provides a useful guide towards thinking about the potential positive impacts of the technology.

Background on Process Automation Software

[20] Bronsoler, *The Impact of Healthcare IT on Clinical Quality, Productivity and Workers.*
[21] Taneja, Klasko, Maney, *Unhealthcare: A Manifesto for Health Assurance.*

Robotic Process Automation (RPA), Intelligent Automation (IA), and Optical Character Recognition (OCR)

Robotic Process Automation (RPA) is software technology that copies the actions of humans interacting with digital technology systems, websites, or software applications to conduct a particular process. Both human and artificial intelligence have the capabilities to exercise judgment, image interpretation, and complex problem-solving. RPA robots, in contrast, produce the outputs based on a set of step-by-step rules, discrete tasks, and deterministic actions fed into the program, tending to focus on repetitive, mundane activities. These activities do not require knowledge, understanding, or insight. RPA is often used in back-office functions that involve extracting data, filling in forms, or moving files. For example, an accountant who is responsible for managing invoices and other financial records such as monetary transactions, checks, and liabilities might be required to copy and paste information from an invoice, such as the name of a company, the invoice ID, and the date of processing to an excel spreadsheet, and then mail that spreadsheet to a superior. With RPA, the accountant can build a software robot that extracts this information automatically and sends the spreadsheet to the superior at the same time every day. RPA sits on top of existing information systems, meaning that the RPA solution has the ability to read data, select buttons and go through the user interface like a person would.

Other examples of processes that RPA can automate include logging into applications, connecting to system APIs, extracting and processing structured content, opening emails and attachments, and scraping data from the web. In sum, many have described RPA as “taking the robot out of the human”. According to Deloitte’s annual RPA survey, global 2021 revenue for RPA is

estimated to reach $1.89B and is growing at ~20%. RPA should not be applied to any and every process; instead, the technology is best suited for clearly standardized processes.[22] To help companies assess which processes are most standardized and thus best equipped for RPA, vendors sell process mining software, which will be discussed in more depth later. One major downside of RPA is that the technology tends to be brittle and is not adaptive, so it must be adjusted if processes change. Changing page layouts or updating software systems that the RPA interacts with could break the RPA bot.[23]

People often confuse the meaning and value of artificial intelligence and RPA. Artificial intelligence makes predictions based on learning patterns from data over time. RPA bots, in contrast, conduct processes that are clearly explicitly defined by a human. RPA is more task-oriented, while AI is more thinking-oriented. AI is also useful for processing language, understanding documents, creating predictions for highly variable processes. Despite the differences in the two technologies, they are increasingly being used in tandem. There are often scenarios in which there is differently structured or missing data moving from machine to machine with RPA. In these situations, artificial intelligence, consisting of trained models, can predict behavior based on contextual information. Because artificial intelligence gathers data from many different sources and is able to make sense of different types of data, adding it to RPA greatly streamlines processes and leads to more efficiencies. In addition to combining RPA and artificial intelligence, intelligent automation also incorporates process management software that manages handoffs between humans and machines, as well as NLP technology that translates data observations to written text.

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[22] Deloitte Insights, *Automation with Intelligence.*

[23] *Beyond RPA: What the Next Phase of Revenue Cycle Claims Process Automtion Should Look Like.*

Common success metrics for RPA technology include FTE reduction, employee experience, and a decrease in rework time. While individuals involved with digital transformation at some healthcare systems might look to RPA as a means to cut costs, other CMIOs, operators and investors view RPA as a means to increase revenue. According to Rak Garg, an investor at Bain Capital Ventures, RPA vendors that point to their technology as a tool to reduce FTE or save hours are seen more as "value capturers", whereas vendors that market their technology as a tool to reduce speed to problem resolution and increase customer and employee satisfaction are seen more as "value creators" and are more likely to command higher company valuations.[24] The latter strategy is particularly crucial for industries and job professions that are in short supply of top talent. Beyond simply automating legacy processes, RPA augments employee work and allows for more time for innovation and human-to-human interactions. This is increasingly necessary in a world where there are thousands of software applications and processes to manage. RPA is instrumental in creating a standardized data architecture that shows a unified view of performance across a hospital.

Optical character recognition (OCR), also known as document extraction technology reads and copies data from a document and then converts it into a format understood by a machine. This is particularly useful for manipulating and analyzing unstructured data in emails, images and log files. OCR is commonly used for extracting data found in invoices, background checks, or revenue recognition processes. OCR cannot understand data on its own, but the digitized text that it creates enables other software robots to read it. It is thus an enabling technology that allows RPA bots to

[24] *Interview with Rak Garg.*

complete tasks that require interpreting data from documents. The most sophisticated automation technology combines RPA, AI, OCR, and computer vision.[25]

RPA in Healthcare

Following manufacturing, healthcare has been one of the fastest industries to adopt RPA. Processes are highly bifurcated between payers and providers which greatly limits the flow of information and knowledge. There is tremendous potential for automation in the payer side, as tasks tend to be more repetitive and administrative. Although it is more challenging to automate processes on the provider side due to the clinical nature of the work involving patient consultations and surgical producers, studies show that 33% of provider tasks could be improved through automation.[26] On the provider side, the goal of RPA in a healthcare context is to be a digital assistant that removes the data extraction and transformation tasks from nurses and other healthcare employees and allows them to instead spend more time providing the highest level of care to patients. On the administrative, non-clinical side, RPA helps finance, accounting, and operations employees work at the "top of their license" and have more time to work on the most complex cases that arise.[27]

While there are dozens of use-cases for RPA in healthcare systems, there are a few processes that are most commonly automated. Detailed descriptions of processes will be included in section four as part of the results section of the study. RPA helps patients schedule appointments without having to interface with hospital employees. This helps triage patients faster, increase appointment turnout and improve the patient experience. Additionally, RPA helps with claim management by extracting,

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[25] Chen, *From the Eyes of F500 Executives.*
[26] Ibid.
[27] Dilmegani, *RPA in Healthcare: Benefits, Use Cases & Case Studies in 2022.*

processing, and evaluating documents and data. RPA also helps with regulatory compliance by helping providers track and document steps in processes that are required for external audits. The use of robots helps with compliance because they guarantee confidentiality. In addition, RPA helps digitize paper documents so that clinicians have an easier time finding data. Specifically, RPA extracts data from legacy systems and enters it into new, digital information systems. Sometimes physicians must input the same data into multiple systems, which is not only time-consuming but also mind-numbing. RPA has the potential to dramatically reduce the time spent on these activities. Lastly, most recently, RPA has helped throughout the COVID-19 pandemic in that the technology notifies nurses with patient COVID-19 test results. Without RPA, this involves logging into lab systems, finding disease codes, and then manually entering the results into a different information system.

Methodology

This study consists of a comparative analysis model that leverages case studies based on a multi-tiered framework. These case studies are based on interviews, background on each of the healthcare systems, and research reports published on healthcare process automation. With regard to the interview portion of the case studies, snowball sampling was used to identify relevant experts. The interviews were not recorded so the descriptions included in the results highlight the main themes from the conversations. For the interviews, the study utilizes a three part framework that seeks to address the considerations and decisions made at each step of the RPA implementation process. The first part of the framework focuses on the pre-automation phase of digital transformation. This section

will reveal information on how people within healthcare systems make decisions around what processes to automate. For example, do they leverage process mining software or wait until an RPA vendor approaches them? The goal of this part of the interview is to establish context around the "before implementation" setting. Gathering robust qualitative data at this stage is important because it will serve as a comparison point with the post-transformation data and show where there was value-added. The second part of the framework will focus on the transformation stage. This section will breakdown the processes being automated and will hone in on specific workflows that RPA is being used for. This draws on Autor's ideas about Polanyi's paradox and seeks to unpack whether individual tasks or jobs as a whole are getting automated. The final part of the framework seeks to create a post-automation profile of the healthcare system adopting RPA. The goal of this section is to extract information about the tangible business benefits and to understand success factors in order to replicate the alignment of stakeholders in other industries. This section will also pinpoint the personnel most likely to positively or negatively impacted by the technology and who is most at risk of replacement.

Part 1: Pre-Automation
• What factors drove you to consider implementing RPA? • What business outcomes are you hoping to achieve by implementing the technology? • Who are the key decision makers in the digital transformation process? • What key criteria do you keep top of mind when comparing vendors? • How do you communicate with stakeholders within the healthcare system about automation?

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Part 2: Automation Phase

- Within your healthcare system, which processes can RPA help with?
- For each of these processes, what step(s) are the bottleneck in the process?
- Which processes are too complex for RPA? Why?
- How would you classify the personnel conducting the tasks getting automated? What skills were they hired for?

↓

Part 3: Post-Automation

- If you have already implemented RPA, how has the technology helped or hurt the healthcare system? Are there any quantitative changes in efficiency that you can share?
- If there are any efficiency gains, what do you find that employees do with the extra time?
- If there are efficiency gains, how does the number of new hires change over time?
- Does RPA implementation create demand for new, previously non-existing jobs?

Sample

This study's sample includes interviews with Chief Medical Information Officers and Digital Transformation executives at six large healthcare systems including Hospital of the University of Pennsylvania, Yale Medicine, Houston Methodist, Common Spirit Health, North Kansas Regional, and Intermountain Healthcare. In total, multiple interviews were conducted with 17 different healthcare stakeholders, including Chief Medical Information Officers, Revenue Cycle Executives, RPA operators, and healthcare investors. Multiple interviews were conducted for individual healthcare systems to guarantee robustness of findings. Studying different hospitals provides variation in philosophy towards retraining versus replacement as well as management style, while keeping constant

the industry and use-cases. Additionally, HUP is in the process of evaluating vendors and understanding the implementation process, while each other the other healthcare systems have already implemented RPA. Comparing the hospital systems approach to implementation will shed light on the different considerations depending on the stage of implementation.

Results

Penn Medicine

Pre-Automation Phase

Penn Medicine consists of six different hospitals, with ten multi-specialty centers, doctor's offices, clinics, and sites. Several interviews were conducted with William Hanson, the Chief Medical Information Officer, Srinath Adusumalli, the Assistant Chief Medical Information Officer, Philynn Hepschmidt, the Vice President of Patient Access, and Thomas McCormick the Vice President of Patient Accounting. Penn Medicine is at the beginning phases of its RPA implementation process. The healthcare system is currently assessing the value the technology brings, as well as the vendors with which it is considering working. The digital transformation team at Penn has been evaluating vendors since 2019, but the pandemic coupled with the plethora and diversity of vendors have slowed down the implementation process. RPA vendors differentiate themselves among several dimensions, including their level of industry-specific specialization, use-cases provided and bundling with other automation tools. Thus, every time one vendor seems to make headway in the sales cycle, another new, slightly different vendor enters the discussion and prompts more deliberations. Penn Medicine is currently

working with stakeholder groups to identify processes that would benefit from RPA and creating process maps to take back to vendors. Some more established vendors such as UiPath provide process mapping and process mining services and come to Penn with processes they feel would be best suited to automate.

When evaluating different vendors, Penn Medicine values expertise in healthcare, due to the vast differences in automating healthcare workflows relative to other enterprise processes for companies in other industries like retail or manufacturing. Secondly, vendors that can automate a multitude of workflows such as pre-authorizations, scheduling and other clinical workflows are viewed in a more positive light than solutions that focus on one type of bottleneck. A third major consideration that Penn is taking into account as it evaluates vendors is the company's size and level of funding. Early-stage startups with limited venture backing and few customers are less compelling partners due to concerns that they could dissolve after significant time, money and resources have been dedicated to implementing the technology. Lastly, in order for Penn Medicine to agree to partner with a vendor, the RPA company must prove not only that their technology is high quality and that insurance companies will also use the technology. Sometimes insurance companies will not agree to use the technology, which eliminates any value generated in two-sided use cases. Additionally, payers are becoming increasingly selective with how they evaluate accounts and eligibility for claim statusing. Insurance companies hire third party auditing firms to screen accounts more agressively and hope that hospitals will not appeal denials.

Vendors use a variety of approaches as a wedge into Penn Medicine's sales cycle. One strategy involves providing a complementary trial with vendor-specific employees operating the technology to

demonstrate how the RPA works and its potential value without undergoing a large scale implementation process. Another strategy involves guaranteeing a specific return on investment and writing a check for the difference if the numbers are not met. With this second strategy, vendors seldom pay the full difference and instead argue about practice not executed properly. The primary goal of implementing RPA technology is to improve patient access as well as clinician and care team well-being. In Penn's patient call center alone, there are 400 full-time employees, and as the volume of calls and patient requests increases, Penn must find a way to add more bodies and satisfy the demand. RPA is an attractive solution because it allows Penn's call center to handle the influx in patient demand.

Automation Phase

For its first iteration of RPA implementation, Penn plans to focus on three main areas: improving patient experience, provider engagement, and revenue cycle management.[28] Regarding the first category, there are several distinct processes that could benefit from RPA. Patients must schedule appointments, order prescriptions, and ask their care team clinical questions. Prior to patients stepping foot in the hospital, they often call the 1-800 Penn phone number to describe their needs and determine what type of care they need. There are as many as 16,000 phone calls every day to the Penn Medicine call center. These phone calls can take up to 40 minutes to properly triage patients, leading to a poor patient experience and a lower number of calls per call center employee in a particular time period. Thus, Penn is considering voice RPA that will automate part of the triage process to help

[28] *Interview with William Hanson.*

patients determine the next steps faster and call center employees to speak to a larger number of patients.[29]

Penn Medicine's second key focus area for RPA adoption, provider engagement, stems from a desire to reduce burnout and improve employee satisfaction during a period where the industry is facing a "Great Resignation". Electronic Health Records (EHRs) were built to digitize billing processes, but not efficiently share data, which has resulted in burnout from excessive data entry. Because EHRs do not talk to each other, doctors are required to interface with many different platforms, manually upload lab results, and communicate with patients through separate platforms, leading to substantial net new work outside of medical procedures and treatments. Because RPA is UI-driven and can easily be trained to copy and paste information, the technology can address this problem by inputting data from one information system to another. For Penn, RPA can extend the capabilities of Penn Chart by scanning documents, and extracting and labeling both structured and unstructured data. Penn also plans to use RPA for in-basket management, to automate the triage of messages. [30]

Lastly, with regard to patient access, there are a number of use-cases that RPA can address to improve access to care. Appointment scheduling is one of the most suitable processes for RPA because of its repetitive, steps-oriented nature. To assist with appointment scheduling, RPA is able to look at both patient and doctor schedules, determine the frequency at which a patient must see a doctor, and cross-reference the availability of both the patient and clinician. Once the patient has had their

[29] *Interview with Philynn Hepschmidt.*
[30] *Interview with William Hanson.*

appointment, they normally have the ability to schedule a follow-up appointment with a Patient Service Representative (PSR) at the front desk; however, when appointments are conducted via telehealth, this is no longer an option. This situation leads to a game of telephone between practice staff and the patient. RPA can also be used to automate interaction with patients to make sure they have scheduled follow-up testing. Lastly, Penn is looking to RPA as a technology to improve data sharing between hospital systems. This is particularly important because oftentimes patients choose to go to Penn Medicine because of referrals from other doctors. In many cases, patients have already been examined by a clinician. Penn Medicine doctors need previous records to best understand the patient's history and the context of the particular ailment, but interoperability between EHRs is notoriously difficult. RPA can help address this challenge by scanning documents from other systems and interpreting the results.[31]

Penn's last key focus area for RPA implementation involves improving processes around revenue cycle management and billing. Specifically, much of the clerical labor involved in revenue cycle management, involving medical coding for prior authorizations is outsourced to India, where workers are well educated but inexpensive. One of the major advantages of outsourcing to India is that because of the time difference, workers are able to work overnight and send back work by the next morning. Over 40% of Penn's revenue cycle management budget goes to salaries for human labor, so if automation is able to reduce some of this cost, the division will save a substantial amount of money. Claim status is the primary revenue cycle management use-case that is suitable for RPA because of its rule-based nature. Software robots are able to work at any time of day or night, further increasing

[31] *Interview with Srinath Adusumalli.*

productivity. This involves automating many of the rule-based steps around prior authorizations. For each of these processes, RPA is automating specific tasks, rather than the entirety of clinical or non-clinical individual's job.[32]

Post-Automation Phase

Penn has not yet implemented RPA, so the post-automation plans discussed were kept in hypothetical terms. Out of any of the workflows described, those involved with call center automation and front desk processes are the first to be automated with RPA. Thus, patient service representatives (PSRs) are the individuals who are at the highest risk of becoming replaced by technology. That being said, according to multiple executives at Penn Medicine, the healthcare system does not view technology as a replacement for front desk employees. Rather, according to Bill Hanson, Penn Medicine instead views technology as a means to augment the day-to-day workflows of these staff members and improve employee satisfaction in a role that is notable for high attrition rates. The goal of RPA is to help these employees power through the low value, low complexity tasks faster so that they not only find their job more fulfilling but also have more time to spend with patients. With the time saved by RPA, PSRs can assist patients with navigating new software systems for making appointments, educate patients on new telehealth applications, and spend more time on more complicated cases where patients need to schedule time with a specific doctor or a specific time or place. This finding conforms to the branch of literature suggesting that automation can create opportunities for new jobs, as Bessen found with the ATM example. Penn Medicine has taken the

[32] *Interview with Thomas Beard.*

stance that they will not lay people off to promote efficiency goals but will rather move employees to a different role within the system.[33] How this process happens is very much dependent on the specific role, the employees skills, and their past experience. For call center employees, the extra time can be spent on training, so that they have more subject matter expertise and can better connect patients with the most relevant doctors. There are several specialty workflows that employees have to learn that are specific to a Penn as a provider network, and right now there are too many errors when it comes to connecting patients to the correct providers. Thus, according to Philynn Hepschmidt, the VP of Patient Access, the extra time RPA saves can be used to align call center employees with specialty practices, the leaders within those practices and learning about the correct protocols and medical terminology.[34]

Houston Methodist

Pre-Automation Phase

Located in Houston, Texas, the Houston Methodist healthcare system consists of eight hospitals, an academic institution, a primary care group and over 300 locations throughout the greater Houston area. An interview was conducted with Brad Shaink, the Administrative Director for the Center of Excellence to understand Houston Methodist's RPA implementation process. Houston Methodist started its digital transformation efforts with RPA in 2019. At the time, the healthcare system was working with Ernst and Young, which helped create a Center of Excellence for RPA and

[33] *Interview with William Hanson.*
[34] *Interview with Philynn Hepschmidt.*

entailed helping Houston Methodist with best practices around the types of processes they were considering automating, vendors to select, and how to align employees. At the beginning of Houston Methodist's RPA journey, the system viewed FTE reduction as their primary success metric. However, as more discussions occurred, the system became increasingly focused on incorporating their core values of service, quality and innovation into success metrics. To decide on which use-cases to automate, the Houston Methodist team used an ROI framework, comparing cost savings achieved with RPA relative to the investment involved with the technology's implementation. According to Shaink, the healthcare system has doubled in size over the past eight years, now employing over 20,000 people. The digital transformation team at Houston Methodist believed RPA and other process automation software could help grow the patient population while keeping quality of care high and not hiring employees at a 1:1 ratio with patient growth. The primary objective of the project was to grow the healthcare system's business while keeping constrained existing support resources.[35]

Automation Phase

Houston Methodist has used RPA to automate over 30 processes, each with varying levels of success, for both clinical and back office employees. Shaink highlighted how RPA was particularly helpful with automating certain clinical workflows that were the source of burnout issues during COVID-19. Since the outbreak of the pandemic, every patient admitted to the hospital was required to be tested for COVID-19. The entire patient population was constantly monitored for positivity rates. Before RPA implementation, nurses received constant alerts whenever a new patient received a

[35] *Interview with Brad Shaink.*

COVID test result. Subsequent to RPA implementation, the result was automatically logged in the patient's record, thus leading to one fewer alert for nurses, reducing alarm fatigue. A second key use-case involved automating prior-authorization processes. This entailed receiving the right insurance from the correct sites, validating insurance depending on each patient's coverage and analyzing any existing prior-authorization information on a particular patient. This can be a lengthy and expensive process if conducted manually. A host of websites exhibit prior-authorization information at a cost, but if a human is toggling between websites for each patient, the process takes a long period of time. Houston Methodist has used RPA to bend the cost curve with this process. A third category of use-cases that Shaink highlighted involved automating human resources-related workflows. Houston Methodist used RPA bots to validate that staff was receiving payment for the correct number of hours worked and that the healthcare system was not overpaying. Another HR workflow automation associated with job terminations involved revoking access to buildings and software applications and deactivating cell phones. The most prominent RPA use-case within Houston Methodist involved automating processes involved with revenue cycle management. One of the most successful automations in this arena involved pre-staged bots submitting claims for Medicare and Medicaid reimbursements. Multiple different bots were able to submit two million claims in mere hours, saving significant time for employees and leaving them with the more challenging, cognitive work. Similar to Penn Medicine's RPA use-cases, the workflows that Houston Methodist's is using RPA to automate are parts, rather than the entirety, of healthcare workers' jobs.[36]

[36] *Interview with Brad Shaink.*

Post Automation

Within Houston Methodist, RPA addresses the "low-hanging fruit", automating the easiest, most mundane tasks. Shaink highlighted that for many of the processes RPA is used in, there is still a "human in the loop". The digital transformation is geared towards allowing employees to work at the top of their license, meaning that if they received a higher level of education, they should not spend their work hours copying and pasting information from one system to another. For back-office employees, the time saved with RPA technology can be used to focus on more complex cases that require a cognitive skillset and involve interfacing with different departments, files, and applications. For clinicians, the time saved opens up more time to be spent with patients and reduces burnout. This outcome is closely aligned with Houston Methodist's values of innovation, quality and service because the RPA enables clinicians to spend more time working directly with patients and non-clinical employees to spend more time improving the patient's non-clinical experience.[37]

North Kansas Regional Hospital

Pre-Automation Phase

North Kansas City Hospital (NKCH) is a subsidiary of Meritas Health, employing over 140 physicians and 40 advanced practitioners in 36 different locations. Todd Beardman, the Chief Medical Information Officer at NKCH shared the hospital's approach to implementing RPA and some of the considerations that went into aligning employees. North Kansas City Hospital's process automation initiatives went live during May 2020. The shortage in supply of healthcare workers prompted the

[37] *Interview with Brad Shaink.*

hospital to seek out solutions to expand their capacity and improve efficiency. After selecting Notable as their partner vendor, NKCH implemented the entire RPA system in a mere six weeks. COVID-19 thus served as an accelerant to North Kansas Regional's RPA efforts. Prior to the pandemic, RPA was not as top of mind. The goal of the initiative was to improve heavy lifting involved with the exchange of information during a time when healthcare workers were in even more short supply than usual. [38]

Automation Phase

The main processes North Kansas City Hospital (NKCH) automated were related to patient registration and check-in. With RPA, NKCH enabled patients to book appointments online and fill out the registration, health risk assessment forms two days prior to their appointment. Without the assistance of RPA, the check-in process on average lasted two to five minutes, depending on the proficiency of the PSR and the cooperation. While this might not seem like a large amount of time, the repetition of the process adds up over the course of a day. Prior to the implementation, clinical care coordinators would send messages manually to patients. A tremendous amount of work went into managing inbound fax messages, referrals, and results. When people came in for check-ups, their doctor would check to see other procedures that the patient was due for. Notable's solution automatically checked for this information, enabling doctors to more quickly identify and care for the highest risk patients. For simple data transfers, NKCH uses the FHIR* specification. Although currently NKCH only uses RPA with patient registration and check-in, their partner vendor, Notable,

[38] *Interview with Todd Beardman*

could use the workflows as a wedge into the healthcare system and upsell over time, after proving the quality and effectiveness of their solution.[39]

Post-Automation Phase

Similar to the previous healthcare systems discussed, the individual whose role is at most risk of replacement is the PSR. These people are hired because of their strong customer service and interpersonal skills. Thus, when the tasks not involving patients are removed, they are able to apply the strengths that they hired for and make new patients feel welcome to the practice. There is also a substantial amount of turnover in PSR positions, so removing the mundane aspects of their job is designed to improve employee satisfaction and retention. Thus, although PSR roles will not be eliminated completely, there will be a substantially lower number of PSR employees needed since the technology frees up so much time. Given the "Great Resignation" and the shortage of clinicians, Beardman indicated that it is difficult to imagine any world in which RPA and other process automation technology replace nurses and MAs.[40]

Following their implementation of Notable's digital check-in technology, NKCH was able to decrease their no-show rate by 23% and serve over 4000 patients per week. To reduce employees' fear of job elimination, the healthcare system framed the technology as a tool to help offload the unenjoyable aspects of employees' work. Initially, there was a negative sentiment among staff because of the new responsibility to learn how to use new technology, not due to fear of replacement. This highlights the

[39] Ibid.
*See appendix.
[40]Ibid.

common concern around employee burnout and how healthcare workers of all types are feeling overwhelmed with their day-to-day work.[41]

Intermountain Healthcare

Pre-Automation Phase

Based in Utah, the Intermountain Healthcare system consists of 24 hospitals and 215 clinics and employs over 2,600 physicians and clinicians. Susan Tew, the Assistant Vice President of Consumer Digital Solutions was interviewed to share her perspective on Internmountain's RPA implementation process. Similar to North Kansas Regional, Intermountain sought out ways to use intelligent automation to improve the patient registration and intake experience. Specifically, upon check-in, patients were required to fill out many different paper forms that repeated many of the same prompts. This contributed to a less seamless check-in process for patients and an increased amount of paperwork for PSRs, which became even more problematic during COVID-19, when touching shared items increase risk of virus transmission. Shoulder to shoulder with physicians, PSRs, and MA's, and the digital transformation team at Intermountain discussed specific workflows that could be expedited with the use of RPA and how those improvements could ultimately help patients receive better care. Albert Marinez, Intermountain's Chief Analytics Officer, expressed, "It can't be this sort of centralized, let's have some major project on how we're going to automate something. Instead can we democratize, can we create skills. Can we equip those clinical leaders with an understanding of what

[41] *North Kansas City Hospital and Merias Health Improve Digital Patient Registration; Reduce Care Gaps by 15%.*

digital tools can do, what robotic process automation can do for them?"[42] Tew emphasized the importance of not introducing technology that eliminated some work and added different work, which would ultimately not lead to any time savings. Another consideration that went into the decision to automate certain processes was the technical lift. Tew and the rest of the Intermountain team favored IA because the implementation time was fast and did not require coding interfaces. Implementing Notable took four weeks to launch since the initial deployment. Lastly, Intermountain wanted an automation solution that would be able to automate many different workflows across the healthcare system. They wanted to avoid having over a dozen systems for a dozen workflows and instead have a unified UI across use-cases.[43]

Automation Phase

As its primary use-case, Intermountain leveraged Intelligent Automation as its "digital front door." Intermountain's intelligent automation system was able to scan their EHR for upcoming patient appointments and use artificial intelligence to personalize check-in forms. Then, the system would automatically send digital patient registration forms, intake questionnaires, insurance information, and consent documents. The information provided by the patients then auto-populates into relevant fields within the EHR, eliminating the repetitive work required by the staff. Following the patient visit, Notable is able to send alerts to patients to help keep them on track with certain medications or post-clinical practices necessary for ensuring long-term health. The platform also asks

[42]Ravindranath, *5 Tech Strategies Health Systems are Testing to Reduce Clinician Burnout.*
[43] *Interview with Susan Tew.*

prompts patients to fill out questionnaires that ask about patient-reported outcome measures (PROMS), which sends data directly to the hospital's EHR. [44]

Post-Automation Phase

By reducing the need to check-in 80% of patients in person, Intermountain needs only a fraction of the PSRs they originally hired. Reducing the number of PSRs needed while improving employee satisfaction is paramount for a role that typically has a high degree of turnover. In total, there was a 25% decrease in check in time, a 91% pre-visit and intake completion percentage, and a 300% increase in co-pay collections. For the nurses and MA's however, the decrease in time spent on paperwork translates to more time with patients. Tew shared how she had a delightful experience while having her blood pressure measured because the staff was not pressured to rush through the experience and manually enter data. Instead, the nurse handled each step of the process with best practice. Tew described how the Intermountain staff was "doing backflips" because they were so pleased with the IA experience. With regard to managing the digital shift, Intermountain shared with employees their plans ahead of time, what to expect, and for feedback. Employees regularly share feature requests for how Notable could further improve their daily workflows.[45]

Yale New Haven Health

Pre-Automation Phase

[44] Ibid.

[45] *Intermountain Healthcare Paqrtners with Notable Health to Expand the My Health+ Digital Platform for Patients.*

Yale New Haven Health System (YNHHS) consists of over 360 locations in Connecticut, New York and Rhode Island and manages over 28,500 employees. Lisa Stump, the senior Vice President and Chief Information Officer of YNHHS was interviewed to share Yale's journey with RPA technology. As of February 2022, Yale is in its fourth year of its efforts around RPA. Stump explained how labor costs for healthcare workers are very high due to increased vacancies and high turnover since COVID-19. Yale thus looked to RPA and other digital transformation technologies as tools to increase employee retention and satisfaction as well as overall efficiency. Yale partnered with Olive to help with prior authorization and has pushed the technology to focus on other areas of operation as well, including 45 other workflows and use-cases across finance, supply chain, inventory management and IT. These additional workflows are each in various phases of assessment, feasibility analysis, build, and implementation. Yale also worked with Cognitive, a company which provides additional revenue cycle workflows as well as "near clinical" workflows, which is a more flexible vendor than Olive. [46]

Automation Phase

Yale has focused its RPA efforts primarily on revenue cycle use-cases, automating tasks that go into getting clean bills out of the door, adjudicating claims, and prior authorization work. RPA is also particularly useful for workflows relating to regulations, compliance and quality assurance. Hospitals are required to submit data to national registries around health outcomes. Without RPA, human employees are required to manually go into EHRs, extract the relevant data and fill out forms for national repositories. Near clinical workflows include RPA bots that are used to answer patient

[46] *Interview with Lisa Stump.*

questions. Throughout, COVID-19, Yale Medicine's call center was getting thousands of calls per day, but did not have enough staff to handle the demand. They thus used voice RPA to answer commonly asked questions, many of which were very clinical questions. The voice RPA served as an initial triaging technology that routed people to the right type of care.

Additionally, at the beginning of the pandemic, COVID-19 testing orders were sent over the fax machine, which forced already busy micro biology labs to spend hours at night typing in fax orders into computer system and processing results. To expedite this process, Yale used Optical Character Recognition (OCR) to screen scrape the content from the page and convert into the system and send in the testing orders. Lastly, physicians have large in-baskets within the EHR with many different types of messages that takes a long time to work through. Yale is pushing its RPA vendors to triage and screen some of the messages in the in-basket to reduce the amount of time physicians have to spend working through their in-basket. Epic, one the two leading EHR platforms, tends to get nervous with outside technology doing clinical work. AI is also able to read radiology images, prioritize patients with the most critical problems.[47]

Post Automation Phase

The personel most often engaging with RPA technology within Yale's system include mid-level business operations employees and management. Stump ultimately envisions RPA increasing management capacity so that each person can take on a bigger span of control. Front-line, entry-level jobs that require more physical labor, such as pushing around wheelchairs or replacing towels are more

[47] *Interview with Lisa Stump.*

likely to be impacted by physical robots but not software automation. Yale has an ongoing focus on thinking about ways to upskill employees so that technology does not replace jobs. To do this, Stump explained that lower-level employees must learn about how to manage the technology that is changing some of their individual tasks. In an ideal world, RPA frees up time for employees to spend more time on complex tasks and with patients. Today, for every ten people, there are 15 people's worth of work, but in the future, as RPA and other predictive technologies can do more and more work and generate more workforce capacity, there will come a time when FTEs might start to be reduced. As departments grow, bots will be able to handle additional tasks that would have previously been completed by a new hire. Stump emphasized the importance of data literacy as an important part of reskilling. To reduce fear of replacement, Yale started with small tasks in a few workflows before expanding. By automating only a small portion of someone's job, RPA was viewed as a helpful tool rather than a replacement technology. At Yale, technology at this point is a welcomed relief.[48]

Discussion:

There are two primary schools of thought as it relates to the impact of automation on jobs: research conducted by Dodel and Mesch illustrates that older people, with more manual or physical jobs are more likely to express concern about technological unemployment, whereas younger people with higher income working in jobs with more managerial or data analysis responsibilities are more likely to view automation as a powerful tool for efficiency gains.[49] This study's comparative analysis

[48] *Interview with Lisa Stump.*
[49] Dodel and Mesch, *Perceptions about the Impact of Automation in the Workplace.*

displays that the winners and losers of RPA implementation from an employment standpoint are not necessarily black and white, but that the technology does ultimately help patients recieve a higher quality of care. Conventional belief would posit that individuals in non-clinical roles would be eventually eliminated in tandem with RPA implementation for more workflows. However, the case studies illustrate that there PSRs positions tend to be understaffed and that there is a constant burden of work that they are responsible for completing. Thus, the automation technology is able to help non-clinical staff process and complete burdensome, low value tasks faster and spend more time addressing specific patient questions. Over an extended period of time, if RPA starts to include more predictive capabilities and handle more complex problems, there is a possibility that these types of employees will be less valuable to hospitals. However, depending on the managerial philosophy of the healthcare system, they will not necessarily be replaced. As a result of the "Great Resignation", there are a multitude of unfilled jobs that these employees could be retrained to be hired for.

Clinical staff, including physicians, nurses, and MAs are almost always made better off with the implementation of RPA, as it eliminates alert fatigue and helps them answer commonly asked questions and messages from patients in their in-basket. The reason why RPA almost always helps, rather than always helps is due to the fact that some automation vendors do not always provide solutions that seamlessly integrate into an existing workflow of a physician. If training healthcare workers to handle new technologies takes significant time, or if workers have to alter their workflow in a way that takes time away from patients, then they do not unequivocally benefit from the technology. Socio-technical systems theory is the idea that the performance of an organizational systems can only be improved if both the social and technical components of a complex system are understood and

evaluated as interdependent. If there is poor fit between the humans and the technology in a system, then more work inevitably falls on the human.[50] This disconnect is clearly seen with the EHR – because the information system is not user friendly to the physician, more work has ultimately been created, and doctors spend more time looking at computers than patients. Vendors that can demonstrate fast implementation time and seemlessly fit into the workflows of physicians are poised to be adopted fastest. That being said, there is finite number of people who understand operations within healthcare systems, and an even smaller number of people who are able to program this knowledge into software systems. The impact of COVID-19 had varying effects on different healthcare systems' time to implementation. For some systems, the pandemic created more knowledge silos that slowed down discussions about vendor selection and implementation. Other healthcare systems turned to RPA as a mission critical solution to ensure the fluidity of healthcare operations and a certain quality of patient access and care.

One key theme from the analysis is that healthcare workflows are significantly more complex than workflows in other industries, putting horizontal RPA players at a disadvantage to healthcare specific vendors. Patients are clear beneficiaries from RPA implementaiton in healthcare, as reduced time to care improves their check-in experience, and helps them receive important information about care faster. From an ROI perspective, each of the healthcare systems are on the whole better off with RPA technology, as it creates additional work capacity and frees up time for staff to work at the top of their liscense. Using RPA as a "digital assistants", healthcare systems are able to serve more patients without having to hire additional staff. While automating workflows for back office and other

[50] Baxter and Somerville, *Socio-technical Systems: From design methods to systems engineering, Interacting with computers.*

non-clinical staff might not deliver a tremendous amount of cost savings relative to clinical workflows, which account for over 85% of healthcare spending, it is still a step in the right direction and provides incremental savings that can add up over an extended period of time. Automating clinical workflows will remain a more daunting task, due to the high degree of complexity and uniqueness each clinical specialty involves.

One key difference between some of the healthcare systems was the timing in which the hospitals pondered the idea of RPA replacing human employees. Penn Medicine took the definitive stance of retraining employees prior to even implementing the technology, whereas the other healthcare systems did not view replacement as even a problem to begin with because the technology was currently being used to assist employees. Future studies could explore what factors lead organizations to create formal retraining programs versus adjust over time as automation applies to more and more use cases. The healthcare systems also differed slightly on the quantity of use-cases that they chose to apply RPA to. This was a function of the amount of time they spent considering digital transformation with RPA, the quality of the RPA vendor's user and customer experience, and the employee satisfaction with the technology.

Predictive technologies such as artificial intelligence, that are able to use deep learning to continuously learn and improve are better poised to help clinicians than RPA. Radiology has been under close examination by those studying how AI could replace human jobs. The speciality has large, categorized datasets that make it relatively simple to train models and is based on image classification, which machines are able to do with a high degree of accuracy.[51] Startups are also using artificial

[51] *Machine Learning in Radiology: Threat or Opportunity?*

intelligence to interpret test results and therefore identify diseases faster. Mark Sendak, a clinical data scientist at the Duke Institute for Health Innovation and highly involved member of the Health AI Partnership highlighted the wide ranging applications of AI in healthcare from improving chronic disease management to monitoring inpatient deterioration. With both AI and RPA, hospital executives must think carefully about their decision proesses for implementing the new technology so that they can move forward in an ethical manner. That being said, because RPA, unlike artificial intelligence, does not replace human judgement, there is less concern that the technology would exhibit any type of cognitive bias.

When considering innovation in healthcare, payors, providers, physicians, technologists, developers and regulators have different goals and incentives. Because healthcare has a more complex ecosystem than other industries, it is in the best interest of entrepreneurs creating automation solutions to think about problems from the bottom up, adopting a local, decentralized, highly specific view and then generalizing up based on the learnings that are able to transfer to other specialties. Scaling looks extremely different in healthcare than in other industries to do the highly specific nature of each speciality and the level of human and patient-centricity involved in day-to-day work. The most effective and beneficial innovation to all occur when cross-functional teams of physicians, non-clinical staff, software engineers, and regulators all work together.

Appendix

Glossary of Process Automation Technologies

Process Mining, Task Mining and Process Design

Process mining technology involves looking at event logs of information technology systems to map out a particular process. For example, a process mining technology might tap into a data source such as SAP or Salesforce, and record every activity and transaction within each state of the process to get a sense of the events that took place. This type of software discovers how processes are conducted and aggregates data on the processes in order to help companies improve the efficiency of their processes. Process mining is useful for identifying operations that could be optimized, areas with bottlenecks and opportunities to reduce costs. Because individual people might have their own unique workflow for a particular process, there can be tremendous variation in how a process is completed, which can make it hard for a company to assess whether RPA could be a useful tool. Process intelligence identifies variances in processes, efficiencies that some people have gained and steps or tasks that have been skipped and could pose compliance risks. The major downside of process mining is that logs can be noisy and do not always capture all relevant actions. Task mining is similar to process mining but instead of using logs, the technology uses computer vision to analyze front end processes on a computer screen. Specifically, task mining involves recording user clicks on one or more interfaces, and building a story about the user's path.[52]

Process discovery is a vital step in any company's efforts to implement RPA because it helps establish the scope of viable processes to be automated. The end result of the process discovery step is a process definition document (PDD) which maps out how a process is conducted and the source that an RPA workflow is based on. The goal of process intelligence is not to automate every process but

[52] Illuri, *Process Mining versus Process Discovery.*

rather to help companies find areas to be more efficient, either with a human or bot. Prior to the introduction of process mining and task mining software, enterprises would pay consultants exorbitant fees to help them map out their internal processes and assess where digital transformation and automation made the most sense. This was expensive, time-consuming, and often based on outdated information. Lastly, process design software uses data collected from task and process mining software to redesign and optimize existing processes. In a healthcare context, mining technologies are used to focus on the patient journey, patient experience with various types of healthcare workers, hospital operations, lab testing processes, social care, and interactions with other healthcare providers.

BPM, and iPaaS

Business Process Management (BPM) software models, measures, and improves processes. Rather than automating a process, BPM practices seek to advance enterprise goals through reengineering processes. BPM involves long implementation time and is typically a top-down effort.[53] Integration platforms as a service (iPaaS) solutions provide centralized platforms that standardize how data flows through applications. These solutions are particularly valuable because the software revolution has given rise to thousands of applications solving different problems. Processes are fragmented across these different applications, and connecting applications from point to point integrations takes an extremely long time. Connecting individual applications is not only time-consuming and disorganized but also can pose security risks when specific applications must be updated. As the number of integrations gets larger, it becomes increasingly challenging to understand

[53] *Business Process Management (BPM).*

where and how data is being used. iPaas addresses these issues by being a common integration layer for applications.[54]

APIs

Application Programming Interfaces (APIs) enable communication between software. APIs are code that receives requests and sends responses for specific types of data. APIs are connected with applications through the back end, whereas RPA is UI-driven and depends on the front end of an information system. In contrast to RPA, which sits on top of information systems and acts as a human-robot for conducting processes, APIs are designed for specific data transfers. RPA makes more sense when there are multiple systems involved and multiple transactions within those systems. One limitation with APIs is that they are not easily manipulatable by non-engineers and require coding to update. APIs and RPA are often used in conjunction with one another.

Fast Healthcare Interoperability Resources (FHIR)

Fast healthcare interoperability resources (FHIR) is an API and information technology standard developed by Health Level Seven Internation (HL7) that describes how data should be structured and organized in order to allow for seamless communication between healthcare applications. Exchangeable data can include lab results, insurance claims, and other types of patient data. One of the aims of FHIR is to improve interoperability between healthcare applications and

[54] *Integration Platform as a Service (iPaas).*

healthcare systems, as well as to make information exchange more seamless between payers and providers.[55]

Profiles of Healthcare RPA Companies

Some industry verticals are better suited than others for tailored RPA solutions due to size, complexity and regulatory conditions. Healthcare is one such vertical because of the large number of complicated, rule-based processes and the over $1 trillion of administrative spend. A number of startups have predicated their solution on the notion that more efficient operations both in clinical and administrative functions lead to lower costs for consumers and improved quality of care. Healthcare RPA companies build up specialized, industry-specific knowledge that some of the large, horizontal players like UiPath or Automation Anywhere do not have domain expertise in.

Olive.ai is a healthcare-specific RPA company that automates workflows in revenue cycle management, supply chain, IT, human resources, finance, accounting, and pharmacy and clinical operations. The startup's specialty is in the revenue cycle management and billing workflows, which involve facilitating money change between payers and providers. Olive also provides end-to-end automation for prior authorization, which enables providers to know faster how much insurance will cover for a particular surgery or treatment. Similar to Olive, Notable also provides healthcare-specific RPA combined with artificial intelligence capabilities and patient engagement technology to reduce costs and improve both employee and patient experience.[56] Notable automates a multitude of

[55] *FHIR 101: Solving Healthcare's Interoperability Problem.*
[56] *Interview with Kirsten Smith.*

administrative and clinical workflows including prior authorization, patient check-in and scheduling, clinical note-taking. These types of automation solutions are valuable because Epic and Cerner, the two most well-known EHRs, are the backbone for medical records but are not good at credentials, revenue cycle management and vendor management.[57] AKASA provides healthcare-specific automation technology for revenue cycle management. Specifically, AKASA predicts patient denials, streamlines prior authorization, and automates patient follow-ups. AKASA management argues that RPA's lack of adaptability and brittleness makes it unsuited for the complexities of revenue cycle management. RPA has strict instructions for given workflows whereas AI/ML algorithms have the ability to learn from events and take into account environmental data.[58] Voice RPA companies such as Syllable and Infinitus System are building technology to automate communication via phone and text and expedite time to care. Voice RPA is useful for connecting patients with providers, scheduling appointments, refilling prescriptions, and navigating online health portals.[59]

[57]Ibid.
[58] Ibid.
[59] *Interview with Philynn Hepschmidt.*

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