DEPLOYMENT OF BUSINESS PROCESS AUTOMATION SOFTWARE AGENTS AND THE FUTURE OF WORK

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ABSTRACT

The thesis explores the impact of a new wave of software application technology that attempts to “mimic” human activities to automate routine and repetitive tasks. The claims made by the technology suppliers is that organisations can reduce reliance on workers by replacing them with more cost-effective software agents (also known as robotic process automation and business process automation using software). The aims of the research are three-fold: firstly, to understand the main determinants that influence the deployment of software agents in the workplace setting and can decisions be explained through existing frameworks and models; secondly, to explore how software agents affect job characteristics, work characteristics and skills; and thirdly, to consider the extent to which the Unified Theory of Acceptance and Use of Technology model (UTAUT) captures the key elements to assess workers’ intentions to work with and use software agents. The nature of the research problem is concerned with analysing a real-world contemporary phenomenon in a natural setting. The research empirically examines the implementation of software agent technology in the healthcare sector through six case studies pre and post implementation in a workplace environment. Participants groups comprised of managers and workers across five departments. To provide structure to capture the data analysis, a logic model framework was used, allowing for a comparison of what had changed between the two phases of the study at each site.

The findings suggest that the implementation of software agents is not straightforward, even for simple tasks and it is not something that can be delivered quickly. To understand the extent automation is implemented, a revised five level of automation taxonomy was developed and assessed. Any level of task automation (i.e. taxonomy level 1 or greater) was found to benefit departments and workers by reducing the need for workers to perform the mundane, route and repetitive tasks. The benefits included automation outperforming workers at certain tasks and freeing workers to have more time to perform other duties.

The research contributes to the continued debate on the skills required to perform work and on the labour use strategies for automation systems. What remains the same is that workers are continuing to use skills to intervene and perform manual tasks when the automation fails. What is new is the troubleshooting skills workers are learning to fix issues with the automation and what is different is the rebalance of work.

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LIST OF ABBREVIATIONS

AA	Adaptive Automation
AI	Artificial Intelligence
BACS	Bankers Automated Clearance Service
BPAuS	Business Process Automation using Software Also referred to as "Automation", "Digital Robot", "Bot", "Robotic Process Automation", "Digital Process Automation" and "Software Agent"
BOTS	Abbreviation for Software Robot. Also see BPAuS
DOA	Degrees of Automation. Also see: LOA
FTE	Full Time Equivalent
HAT	Hire Applicant Team
HCI	Human Computer Interaction
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IS	Information System
IT	Information Technology
LOA	Levels of Autonomy. Also see: DOA.
N/A	Not Applicable
NAF	New Appointment Form
ML	Machine Learning
OECD	Organisation for Economic Co-operation and Development
ROBOT	Refer to BPAuS
RPA	Robotic Process Automation. Also see: BPAuS
TA	Thematic Analysis
UTAUT	Unified Theory of Acceptance and Use of Technology

Chapter One: Introduction

1.1 Context

This research is located within the field of automation and in particular the new wave of automation technology that have emerged since 2014, for example business process automation and chatbots (Lacity et al. 2015a; Chaves and Gerosa 2019). In this study, the context of the technology is about the use of specialist software to imitate the actions of a human performed using a computer, in order to automate business processes and tasks. The aim of the technology is to reduce reliance on human workers and in its place deliver a "digital workforce" (Lacity et al. 2015a).

For the purposes of this study, the label "Business Process Automation using Software" (BPAuS) is used since it more appropriately sets out the connotations of the technology employed, rather than the alternative industry marketing label "Robotic Process Automation" (RPA). This is because the reference to "robotic" in the label RPA is misleading to some people and can infer the use of physical machines or devices (Deloitte 2016; Poussa 2020). There is no agreed definition of the term RPA and the present discourse and different interpretations of RPA continues to cause considerable confusion. BPAuS is defined as the use of software based technology that can operate across any application systems to seamlessly mimic and automate simple rule based repetitive tasks manually undertaken by a person and performed using a computer. This definition is based on the authors' field experience of using this type of technology and from the limited literature presently available.

This study focuses on the implementation of BPAuS technology in the National Health Service (NHS) in Wales. In 2017 the NHS has decided to invest in the technology to understand if it is the answer to ameliorate budget constraints and increase service demands. As an employee of the NHS, working in digital technology for over 17 years, there was an opportunity for the researcher to explore this new wave of technology.

The aim of the study is to address three Research Questions (RQ), RQ1) to understand the main determinants that influence the deployment of BPAuS technology in an NHS workplace setting and can decisions be explained through existing frameworks and models; RQ2) how does the use of BPAuS technology affect job, skills and work characteristics and RQ3) to what extent does the Unified Theory of Acceptance and Use of Technology (UTAUT) model capture the key elements to consider NHS workers intention to use BPAuS technology.

Since the early 1960s, processing capacity of computers has doubled every 18 to 24 months in accordance with Moores Law (Moore 1965), with microprocessors occupying less space (Mack 2011; Ford 2015) and manufacturing costs declining. Supplementing this movement has been the advancement of telecommunication systems, moving from analogue to digital techniques, in turn providing new possibilities to 'connect' more telecommunication and information services using computer systems (Hilbert and Lopez 2011). The ramification of this is the increased capabilities of computers to manage more complex processes and data, become more responsive and agile in their environments, deliver greater mobility across devices and seamlessly communicate with other computer systems, devices and with users over telecommunication networks.

Advances in technology have provided opportunities to explore the organisation of work, new capabilities and new ways of delivering services. One of these new capabilities is automation and the ability to perform tasks autonomously that previously could only be performed by a person (Black and Lynch 1997; Dolci et al. 2017). Although there is no unified definition of the term automation (Beer et al. 2014), Parasuraman et al. (2000: 287) defines this as "a device or system that accomplishes (partially or fully) a function that was previously carried out (partially or fully) by a human".

The arguments for utilising BPAuS technology are that an automated task can be performed repetitively at much lower cost than a person undertaking the same task, whilst increasing compliance, doing more work in less time, performing tasks more consistently and with fewer mistakes. In turn, this could improve the quality of work produced for the organisation (Lacity et al. 2015a) and change the future of work through shifts in workplace jobs, skills and work characteristics. The advancement in automation and machine capability is argued to outperform human performance in a range of activities. This has potential consequences for workers across industry sectors and occupational groups, their skill levels and salaries (McKinsey&Company 2017b).

As previously mentioned, the label RPA is not used because of the considerable confusion and the different interpretations that exist, for instance Willcocks and Lacity (2016) define RPA from the context of what they term 'Service Automation adoption' and describe it as a software based solution, where the software 'robot' is configured to do the work previously performed by a person. In the case of McKinsey&Company (2017a), RPA is defined as one core technology activity in the broader Intelligence Process Automation (IPA) solution, with the remaining core technologies comprising smart workflow, artificial intelligence (AI), machine learning, natural language generation and cognitive systems. In 2017, the Institute of Electrical and Electronics Engineers (IEEE) technical standards organisation, dedicated to advancing technology for humanity, established a working group to build a framework for terminology that incorporates RPA and AI (IEEE, 2017). In 2019, the working group published draft recommended practice for the purpose of promoting clarity and consistency in the use of software based intelligent process automation terminology (IEEE, 2019).

Section 1.2 outlines the research organisations. The motivation for the research is outlined in section 1.3, with section 1.4 setting out the structure of the thesis.

1.2 Research Organisation

The National Health Service (NHS) in Wales is a complex organisation, with many legacy applications, systems and services that are in need of modernisation. The NHS remains under considerable pressure to make best use of the finite resources available whilst meeting the increased demands on services. The Welsh Government have made significant digital funds available as a policy directive, for instance Digital Strategy for Wales (Welsh Government 2021). This funding is intended to support the NHS explore new ways of providing services to deliver operational efficiencies, deliver value-based care, improve patient outcomes and support healthcare professionals make timely and informed decisions. It is expected that the use of technologies such as automation and artificial intelligence (AI) will lead to situations whereby "AI will allow doctors to be more human" (Academy of Medical Royal Colleges 2019).

The culture, values and division of labour within the public sector for instance the NHS contrasts with those in the private sector from a number of perspectives. For instance, in the public sector, the focus is on the delivery of non-profit services and in Wales minimum consideration is given to competition. This contrasts with the private sector where the focus is normally economic profit and competitive advantage. Organisational change in the private sector tends to be more fluid to support the delivery of expected economic benefits (Bekkers et al. 2013). Perhaps reflective of this, investment in technology in the public sector has lagged behind that of the private sector (Bannister 2001). Organisation and service change in the public sector may be more challenging than the private sector due to organisational culture and influences of trade unions (Fernandez and Rainey 2006; Lucio 2013). There are many complex factors that can determine the success of implementing technology for the worker and for the private and public sector organisations. These factors are explored further in Chapter 2 and can include, resources (staff and technology), impact on job roles, skills and workers' acceptance to use the technology. Understanding whether the healthcare public sector embraces new technology and implements BPAuS technology presents an interesting area for this study.

1.3 Research Stimulus

Suppliers of BPAuS technologies claim that there is scope for organisations to replace human workers with software applications designed to fully automate all routine and repetitive tasks. The marketing claims are that organisations can quickly implement the technology, no longer require a larger workforce to perform these jobs, with workers being freed to work in new roles (Hodson 2015; Madakam et al. 2019). Such marketing claims in turn suggest that significant savings and greater organisation efficiencies can be delivered. The research undertaken for this study is important; it can evaluate critically these claims and thus assist policy makers in developing workforce strategies to support the future of work. The results can assist organisations to fully consider and assess the implications of implementing the technology and how it may change the dynamics of work and how services are delivered. This was one of the motivations for the research.

A further inspiration for the research is the limited number of studies exploring BPAuS technologies as they are implemented (Lacity et al. 2015b; Willcocks and Lacity 2016; McKinsey&Company 2017b) to understand the reasons for considering the technology and what it has meant afterwards in a workplace setting. There are also few studies exploring the technology against existing theoretical frameworks and models, for instance Parasuraman et al.'s (2000) framework on types of tasks receptive to automation, levels of automation and the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The frameworks and models were applied in this study and the findings suggest how such frameworks need to be improved to make them suitable for BPAuS technologies.

To answer the research questions, the research draws on social science literature, information technology literature and frameworks to examine the interplay between the technical and social relations in the deployment of BPAuS technology. To understand any meaningful change on the NHS and workers, there is a pre and post-automation phase to the implementation process. The stimulus is to contribute to existing social science literature on social and economic implications of automation, as well as contribute to the technical considerations observed in information technology and system science literature. The motivation includes enhancing frameworks and models for use in practice when exploring BPAuS technology.

1.4 Thesis Structure

The thesis is structured into eight chapters.

Chapter two provides relevant background information that contextualises the work presented in this research within the domain of automation systems, in particular in the workplace and the use of software-based process automation technologies. The chapter also examines theoretical models and frameworks that have been adapted and extended to explain workers' attitudes and determinants of automation acceptance. The degree of interaction that may arise between human workers and automation are also explored. The literature is explored from the context of organisations in the healthcare sector and the impact on jobs, skills and work characteristics. The final section sets out the research aims and objectives.

Chapter three presents the methodological approach adopted for the research, the methods used for data gathering based on multi-case study design, and the constructs used in the design of the questionnaires and interviews. The chapter also describes the coding and analysis process used and the limitations of the research approach as well as the ethical considerations.

The next three chapters (chapters four to six) present the findings from the empirical data collection across each of the case study sites: chapter four providing the results on the processes and activities before the automation was implemented; chapter five presenting the results following the implementation of the automation or where the automation moved into abeyance; and chapter six uses the findings to consider the Unified Theory of Acceptance and Use of Technology (UTAUT).

Chapter seven, draws together the findings from the case studies and discusses them against existing literature, the frameworks and models used in the study. The chapter also reflects on the extent the research questions have been answered. The final chapter provides concluding remarks on how the thesis contributes to academic advancement, policy and practice. It also outlines the limitations of the study and suggests avenues for future research.

Chapter Two: Literature Review

2.1 Introduction

A review of the literature is presented in this chapter on the different strands of technology-based automation systems, with specific focus on task automation delivered by software applications rather than physical machines. This is principally explored from the context of the healthcare sector, the workplace and the different taxonomies of automation and what this means for job, skills and work characteristics. Section 2.2 contains a review of literature on traditional forms of software-based automation technologies and explores their impact and consequences for workplace change. The literature is also reviewed for evidence of perceived organisation opportunities and technical challenges arising from deploying automation. Section 2.3 examines theoretical models and frameworks that can be observed in technology and computer science literature that attempt to explain task selection for automation, workers' attitudes and determinants of automation acceptance and explores the degree of interaction that may arise between human workers and automation. Section 2.4 contains a review of the new wave of automation technology, labelled Business Process Automation using Software (BPAuS) and explores how existing frameworks and models may be adapted and extended to understand whether the consequences of the new wave of software automation technology is potentially different to other forms of automated technology. The aim is to provide an understanding of current literature and to highlight existing gaps and shortfalls in the literature aligned to the research aims and objectives detailed in section 2.5.

2.2 Impact of Technology and Automation

There has been long standing interest in the consequences of technology in the workplace (Markus and Robey 1998; Franck 2018), with studies producing conflicting results on the impact on job roles and skill sets and the professional status of workers (Birenbaum 1982; Mamaghani 2006; Danaher and Nyholm 2020). Some studies (Leavitt and Whisler 1958) have been pessimistic about the impact of technology and automation, citing that technology would dramatically change organisations and predicting that this will result in the disappearance of management jobs and the centralisation of services. Alternative studies (Simon 1977; Spencer 2018) were more optimistic about the impact of technology, predicting that it would not have any significant impact on overall employment and arguing that whilst it may reduce some types of job roles (those most suited to automation), employment and wages would increase in areas of skill specialisation to maintain and manage the automated systems. Autor et al. (2003) argues that computerisation has substituted a limited set of well-defined human tasks that are routine and repetitive, in turn altering job skill demands. These debates and conflicting predictions have continued over the last decade (Frey and Osborne 2013; Autor 2015; Arntz et al. 2016). The nature of automation technologies used in the workplace is explored in the next section and this is followed by a review of the potential implication of these technologies for jobs, skills and work characteristics.

2.2.1 Workplace Automation

In the workplace, the use of automation technologies is not a new phenomenon, with Holder et al. (2016a and 2016b) arguing that it is changing workplace practices and how tasks are performed. What is novel is the new wave of software-based process automation technologies that have started to emerge. Combined with Artificial Intelligence (AI) software capabilities, these have been viewed as a step change to delivering what has been called the next (fourth) Industrial Revolution (Chui et al. 2015; Ra et al. 2019; Danaher and Nyholm 2020).

There are many broad strands of automation technologies discussed. One strand is the use of physical robotic devices and machine automation (Collier 1983; Barrett et al. 2011; Sim and Loo 2015; He et al. 2017; Johnson et al. 2017). Robotic devices supported by intelligent software applications are used in many business sectors such as the automotive industry to support the building of vehicles and in the manufacturing sectors to produce high volume products (such as circuit boards). In healthcare, robot devices are used in pharmacy to manage the dispensing of medicines (Franklin et al. 2008; Spinks et al. 2016), to assist physicians perform less invasive and more precise surgical operations on patients (Camarillo et al. 2004; Gomes 2010), in biomedicine sensing devices (Tiwana et al. 2012) in medicine aiding devices to infer probable health conditions on patients (Kononenko 2001; Wong et al. 2011) and in automated guided vehicles to move food and laundry around hospital sites (BačÍK et al. 2017; Pedan et al. 2017). There are also the professional service robots (Hinds et al. 2004;

Osch et al. 2014; Pino et al. 2015) that use intelligent software applications to assist workers in the workplace. The service robots are physical moveable devices that can respond to spoken questions, track people and objects whilst navigating between workplace settings to support workers. A less intelligent form of service robots are automated guided vehicle, a robot capable of picking up and transporting cages containing linen, food and waste (Lloyd and Payne 2021). A second strand is termed “office automation” and this is seen as altering the nature of office work by replacing clerical and administrative workers (Olson and Lucas 1982). The aim is to include the delivery of increased workplace procedural efficiencies and manage the workload demands of the organisation by replacing manual tasks with technology (Coombs and Jonsson 1991). The types of technologies used in office automation include computers, printers, photocopiers and telephony systems. Office automation incorporates the use of software applications, for instance word processors and the electronic transmission of mail and documents as an alternative to manually writing documents and sending the document through the postal service (McKinsey&Company 2017a). Braverman (1974:266) refers to this “mechanisation of the office” being applied to routine and repetitive operations that included payroll, accounts payable and inventory control, with the automatic systems for data processing re-unifying the labour process by eliminating some of the many steps assigned to workers, in turn reproducing the labour process in compressed form.

A third strand is termed “AI” (Artificial Intelligence). It brings together what was previously labelled intelligent software applications and extends the capabilities to also create human like intelligence and communication (Kelley 2020), for instance Chatbots. Chatbots are software programs that use natural languages to mimic human conversation to interact with people (Shawar and Atwell 2007). They are usually used for the purpose of providing specific types of responses to questions a person may ask (Chaves and Gerosa 2019), for instance, some healthcare organisations use a Chatbot to interact with patients with specific disabilities (for example, vision or physical) or have special needs to support well-being management (de Filippis et al. 2020).

Advances in AI have resulted in more sophisticated and interactive computers, with some people not realising when they are having a conversation with a computer. There is much debate on what constitutes AI, what AI can do versus what is conveyed by suppliers and the conflation with automation and autonomy (Leins 2019; Roff 2019). The debate on what constitutes AI is outside the scope of this study. There are also ethical and moral considerations on whether a human should be given the choice to have a conversation with a computer rather than a person, especially if they have specific feelings about using the technology (Rivas et al. 2018). With AI being able to potentially make more complex decisions and learn to perform tasks autonomously, this may further reduce the need for the involvement of people (Montealegre and Cascio 2017). Despite the potential of AI in healthcare, Kelley (2020) argues that the pace of adoption is slow and generally limited to specific applications, for instance image analysis and appointment books. There are many factors impacting on AI, including the risk and safety concerns and the effects on fairness treatment in the decisions made by AI, by limiting unconscious bias and minimising scripting errors (Rajkomar et al. 2018; Cheatham et al., 2019). Frank et al. (2019) argues that AI has the potential to change the characteristic of jobs impacted by automation, with the nature of work for highly educated and well-paid jobs also altering, rather than just the lower paid routine jobs. The potential implications for jobs, skills and work characteristics may also apply to task automation technologies and this is explored further in the next section.

2.2.2 Automation - Job, Skills and Work Characteristics

Over the decades studies have explored the impact of technology change and automation on workers across industry sectors, occupational groups, skill levels and salary (Handel 2004; Kaber and Endsley 2004; Lin et al. 2010; Wajcman 2017; Danaher and Nyholm 2020). This has included the impact on professionals and how they have sought to protect their status from this sustained “assault” on their authority and autonomy (Freidson 1990; p179). The impact of technological change on skilled workers continues to spark much debate, with authors such as Braverman (1974) and Friedman (1977) postulating that managerial strategies in the workplace are aimed at removing the power workers have by controlling the skills they possess and reducing the pleasurable nature of work. These debates continue to the present day.

There is a broad range of studies available on the impact of technology and automation on the organisation of work, job roles and skill set in the healthcare sector. There are the empirical studies that explore the extent roles can be automated (Bennie et al. 2013;

Sampson 2020), the impact of technology on skills (Willmer 2007; Ward et al. 2008; Cornford et al. 2009; Ra et al. 2019), resistance to use technology (Bhattacherjee and Hikmet 2007; Nam 2018) and impact on employment (Frey and Osborne 2013; Nedelkoska and Quintini 2018). There is also a broad range of non-empirical studies that predict the impact of technology and automation on work (Simon 1977; Hall and Walton 2004; Ford 2015; McKinsey&Company 2017a; Arntz et al. 2016; Autor 2017; Hunt and Nunn 2017; Acemoglu and Restrepo 2019).

The types of roles that can be automated are suggested to include tasks that are repetitive, routine and require little or no judgement (Ford 2015; Sampson 2020). Studies provide mixed views on the extent to which automation will lead to unemployment. Chace (2016) argues that 5% of all jobs across all sectors are capable of being fully automated and 60% of jobs could have at least 30% of their activities automated (p. 45), and this may lead to "technological unemployment" (p. 4). The conjecture presented in some studies (for instance Frey and Osborne 2013) is that most occupations in US healthcare are in the high-risk category for automation over the next two decades, for instance 47% less medical transcriptionists will be required (Sampson 2020). Alternative studies (for instance Autor et al. 2003; Smith and Anderson 2014; Autor 2015) have shown that despite proliferation of automation, relative increases in US employment continues with no sign of wages curtailing or automation resulting in a net loss of jobs.

Acemoglu and Restrepo (2019) argues that whilst automation gives rise to decline in certain jobs, this is being offset by the creation of new jobs and new tasks for workers. The extent of the net displacement is dependent on the nature of the job being automated. In healthcare, automation is creating new jobs, for instance medical data scientists (Ho et al. 2019) responsible for collecting clinical data for AI automation systems to use. Computer technician jobs are being created to build and maintain the automation systems. There is a variety of new tasks also being created, with Helldin (2014) citing that these include monitoring the automation and fixing issues when the automation fails. The evolving roles are claimed to enable workers with mastery of complex interdisciplinary skills to perform additional tasks, allowing workers to engage in new roles and develop new capabilities and skills (Barrett et al. 2011; Smith 2016). A further factor suggested for not observing a net loss of jobs is the numbers of tasks that cannot be automated at present, for instance in radiology, the skills needed are more than just interpreting images, it also requires complex judgement and ethical decision making, sometimes in consultation with other clinicians (Davenport and Kalakota 2019). However, it is difficult to ascertain how many jobs are created or lost through office automation as they are also accompanied by changes in healthcare provisions and the re-qualification and reskilling of workers (Hoos 1960; Adler 1986; Nedelkoska and Quintini 2018). Some of the organisation opportunities and challenges with using automation are examined in the next section.

2.2.3 Task Automation - Organisation and Technical Considerations

A number of potential organisational benefits associated with task automation are discussed in the literature (Black and Lynch 1997; Dolci et al. 2017), for instance, improved business processes and labour productivity (Didham et al. 2004); more back-office business operational efficiencies through improving existing processes and in turn increase throughput (Stead and Lin 2009); to simplification of the management of system complexity; and reduced human variability and human errors, such as prescribing errors (Bates et al. 2001; Sharma 2017). These benefits are argued to be dependent on the organisation and context within which automation is applied. In the context of the healthcare sector, Barrett et al. (2011) state the opportunities of task automation include the ability to automate complex diagnosis monitoring activities, such as managing and archiving radiography digital images (Cooper 2001; Salsberg 2002) and automating the testing of complex medical equipment (Frize et al. 1995).

Task automation can also provide opportunities to improve the productivity of workers (Acemoglu and Restrepo 2019). Automation can introduce greater predictability (Zuboff 1989), ensuring tasks are completed when required without the concern for whether a worker is available or has the necessary skills or knowledge to perform the task. Hawthorne and Anderson (2009) analysed 69 pharmacy workforce papers (48 peer and 21 non-peer review) published between 1998 and 2008. The review highlighted that the use of technologies represented opportunities for pharmacists, with automation providing pharmacists with supplementary controls and checks when dispensing medicine. This in turn reduced the rate of dispensing mistakes that would occur due to human error, for instance wrong quantity or selection of an incorrect drug arising from similarly named medicines. These findings concord with Franklin et al.

(2008) who assessed two dispensing sites in a UK hospital using a before and after observation study of dispensary staff. Automation dispensing machines and software to perform automated checks and controls were found to improve response time to prescribe prescriptions. In a busy pharmacy department, automation allowed the pharmaceutical skills of staff to be better utilised, for instance to spend more time with patients to fully understand allergies to certain drugs and ensure the most appropriate medicine was prescribed. The study did not examine the consequences for existing staff skills, job roles and whether automation was used to supplement or replace dispensing staff.

The assertion (Wiener 1989) that introducing new technology has a positive outcome for workers, jobs and the organisation has been questioned. Empirical studies (for instance Inagaki, 2003; Parasuraman et al. 2007; Parasuraman et al. 2009; Parasuraman and Manzey 2010) have highlighted at least six potential challenges with task automation: trust, boundary of responsibilities, deficient automation design, loss of situation awareness, automation complacency and collaborative decision making. The first challenge is the lack of trust by the human in the automated aids (Sanders et al. 2011; Miltgen et al. 2013) and the decisions these systems may make without human intervention. There must be confidence in the actions taken by the automation for workers to use the technology (Lee and See 2004). Trust is considered in terms of the automation performing as expected (i.e. suitability, reliably, competently, accurately), correctly processes the activities (dependable, controlled and predictable) and meets the intended purpose (motivates, benevolence). This is linked to considering workers acceptance to use the technology during automation design and the determinant constructs of usage behaviour and intentions of technology, these are explored in the next section.

A second challenge is clearly understanding the boundary of responsibility between the human and automation agents, with the human agent also fully understanding the limitations of the automation agent (Inagaki 2003). A problem that arises when tasks are shared between agents and when each agent perceives the task to be another agent's responsibility. This gives rise to the psychological effects of the human reducing their own effort and responsibility to monitor and control the outcomes, with the expectation that the automation agent will manage the situation, if issues arise. This is linked to understanding the level of automation deployed explored in the next section and if the task is not fully automated then who is responsible for taking control.

A third challenge is deficient automation design that leads to the implementation of automation systems potentially failing or giving rise to tasks not being completed in any controlled manner (Lee and Seppelt 2009; Wickens et al. 2010). In some instances, the automation was viewed to increase a human's workload. Wiener's (1989) study of US airline crew found 50% of the pilots interviewed/surveyed felt automation actually increased their workload during high periods of automation activities and reduced their workload during low periods of automation activities. More concerning was that some pilots 'disabled' the automation, reverting to manual control during periods of high workload. Therefore, the automation design needs to fully address the impact on the person, including on their performance and motivation (Gibbs 2017). The design also needs to consider the nature of potential incidents that can arise and can be foreseen, for instance if the automation failure could impact the well-being or health of a person or do potential harm to the organisations then the automation design has to address every potential failure point of the task, no matter how unlikely it is for the situation to arise (Woods 1996). This is linked to understanding whether the task is suitable for automation, explored in the next section.

A fourth challenge occurs when a person loses the situation awareness required to complete a task resulting in them being unable to take the appropriate corrective action (Parasuraman et al. 2007). This condition can arise when the person is not appropriately trained to understand the actions of the automation agent or when the person misjudges the action or fails to compensate for any unexpected situation, such as software failure or failure to achieve desired outcomes. In these situations, the person is learning new skills without necessarily being given appropriate training (Helldin 2014). Wiener's (1989) study of pilots highlighted that pilot training did not address how to handle situations when automation loss occurred and it was necessary to revert back to the manual activity. This meant that the cognitive abilities to know what to do in the situation and take control of the situation was impaired. The pilot skills focused more on ensuring the equipment was working rather than having the broader skills necessary to manage the situation if the automation failed. The nature and structure of the pilot's tasks changed. Easy tasks were made easier and more difficult tasks were made harder – a phenomenon that has been termed “clumsy automation” (Lee and Seppelt 2009, p. 419). Wiener’s (1989) study does not detail the impact on the skills lost due to automation and this is subject to further investigation.

The third and fourth challenge on deficient automation design and situation awareness was also evident with the Boeing 737 Max airplane where the software automation was poorly designed causing two airplane crashes (Johnson and Harris, 2019). In the incidents, the Boeing 737 Max automation ignored the actions of the pilot and performed the tasks it was programmed to complete. The lack of pilot training to understand the design of the automation also meant pilots did not know how to overrule the automation to take manual control.

A fifth challenge is ‘automation complacency’. In this situation the human expects the automation agent to complete its activities in all expected situations without any errors and without human intervention (Parasuraman and Manzey 2010). Parasuraman and Manzey (2010) identified that practice and experience do not appear to mitigate against automation complacency or bias. Automation bias is the propensity for humans to favour suggestions from automated decision-making systems and to ignore contradictory information made without automation, even if it is correct (Cummings 2004). Possessing specific experience of automation failures may reduce the extent of the effect on complacency. The study identified that the greater the rate of automation failure, the reduced rate of complacency, with considerably less being known about relevant factors modulating the degree of automation bias. Automation bias and complacency were also viewed as increasing by the greater level of automation (LoA) introduced, although the study did not explore LoA.

A sixth challenge is how a human agent and automation agent would collaborate to complete a business process if both types of agents make autonomous decisions (Inagaki 2003). In particular, if the decision made contradicts the decision proposed by another agent. These considerations require cooperation between all agents and this necessitates collaborative working (Fink and Weyer 2014; Grote et al. 2014), with agreement on the boundary of decisions different agents are permitted to make. One of the considerations surrounding process activities and decision making for all agents is the quality of data available to support the actions taken. Studies on process management, such as Falge et al. (2012) and Cappiello et al. (2015) highlight that the quality of data has an impact on user knowledge to support decision making, citing that poor data (for instance, out-of-date, incomplete, inaccurate) causes failure of the business process. This in turn potentially has implications on the suitability of tasks for automation. The Falge et al. (2012) argue that a method to deliver quality improvements in the data is through redesign of the process, whilst Canhoto and Clear (2020) argue that the use of AI could be used to improve the efficiency of business processes.

This section has highlighted that studies indicate there are considerations and challenges with delivering automation. Some of the challenges may relate to automation design and the level of interaction and collaboration required between the humans and automation. Although existing social science literature explores the challenges of automation from the context of social, economic and political implications , it does not fully explore the technical considerations and the interaction between people and automation technologies that can be observed in information technology, computer science and system science literature. These considerations include different taxonomies of automation and models used to assess people intentions to use technology. To fully explore the phenomenon that connects people with automation technology, for instance BPAuS, it is important to bring together both sets of literature to examine the interplay between technical relations and social relations. This in turn provides an opportunity to learn and create new areas of knowledge and to understand whether the existing challenges and considerations also apply to BPAuS technology. The next section explores the different types of interactions and the considerations for automation design that can be observed in technology and computer science literature that is relevant to this study.

2.3 Human-Automation Agent Interaction

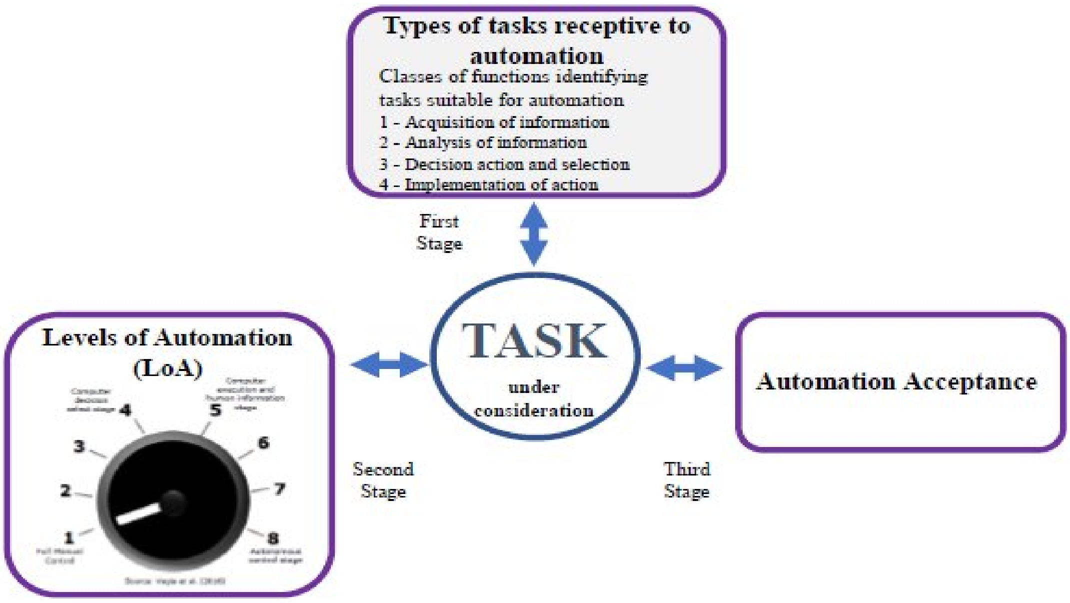
A business process is typically broken down into discreet units of work (i.e. tasks) that are integrated and interdependent on other tasks to complete a job (Handel 2004). Susman (1970) argues that when individual tasks are assigned to workers and to automation then this affects the patterns of interaction required among workers to complete a job. The extent of the interaction is dependent on the level of the automation introduced and the rigid nature of the work. If the automated task cannot perform autonomously in all situations, for instance, when there are issues with the data to be processed or the computer systems being used stops working, then this gives rise to some form of co-operation and interaction being required between the worker and automation to complete all the tasks as a series of links in the chain. This is a process Autor (2017) refers to as the 'O-ring production function' where all the links must hold for the job to succeed (Michalos et al. 2015; Danaher and Nyholm 2020).

Literature on technology and computer science use the term 'agent' (Davis 1997; Christoffersen and Woods 2002; Ruiz and Uresti 2008; Tweedale 2013) to describe a type of object (whether in human form, physical machine form, software form or another form) involved in performing a task, for instance human agent, automation agent, software agent, robot agent. The term 'human' (Danaher and Nyholm 2020) is generally used to denote a person that is involved in performing a task. However, the reasons for using these terms are not clearly elucidated. There are also many terms used to describe the degree of interaction between human and other forms of non-human objects (Young et al. 2007; He et al. 2017; Johnson et al. 2017; Kumar et al. 2019). These include Human-Machine Interaction (Grote et al. 2014; Pacaux-Lemoine and Millot 2016), Human-Computer Interaction and Human-Robot Interaction (Drury et al. 2003; Hinds et al. 2004; Weiss et al. 2009; Michalos et al. 2015). These interaction terms are used interchangeably and this can cause confusion. For the purposes of this study, the following terms are used. 'Agent' alone is used to denote an object, whether human form or non-human form if the reference to the object type is not significant to the research context. The term 'automation agent' is used where the specific type of non-human object (for instance software, robot, machine) is not significant. The study is located in an office workplace setting, where human and software forms of automation objects interact, therefore to reflect the research context, the term 'human worker' or 'worker' is used to denote the human object form and the term 'software agent' is used to denote the software object form.

The successful automation of tasks and the extent of any interaction required between human and software agents can be considered in terms of three stages of technology automation design (see Figure 1, adapted from Parasuraman et al. 2000). The first stage 'types of task receptive to automation' (see Section 2.3.1) is important because not all tasks can be automated, for instance if the task require judgement to be applied, task has complex decision pathways or if the task requires access to paper documents. The second stage is 'level of automation' (LoA) (see Section 2.3.2) which is the extent the automation agent requires some degree of human intervention and control to manage the business process. In this stage it is important to understand how automation impacts on the workers' skills needed to manage the relationship with the automation agent and what this means for job and work characteristics. The third stage 'automation acceptable' (see Section 2.3.3) concerns the extent a human worker accepts and works with the automation technology. This stage is important because if the task is not fully automated then some form of co-operation will be required with the human worker, for the worker to intervene when required to ensure the task is completed. Some studies explore each of these stages in isolation (Venkatesh et al. 2003; Arntz et al. 2016; Vagia et al. 2016), with other studies (Parasuraman et al. 2000; Grote et al. 2014) exploring two of the three stages (types of tasks receptive to automation and levels of automation). There are limited studies that explore all three stages collectively when designing and considering tasks to be automated. For the purposes of this study, Parasuraman et al. (2000) framework has been adapted as presented in Figure 1, to illustrate all three design stages together (types of tasks receptive to automation, levels of automaton and automation acceptance). The next section explores each of the three stages further.

Figure 1 – Three stages of automation task design

(Adapted from Parasuraman et al. 2000)



2.3.1 Types of tasks receptive to automation

The first stage in automation design describes the tasks and activities that are considered to be receptive to automation. Not all tasks can be automated and the purpose of this stage is to identify the most appropriate tasks. There is no consensus on how to identify suitable tasks, however, Parasuraman et al. (2000) propose a framework to aid identification. The framework was developed following a systematic review of empirical studies on human interaction with automated systems. The framework describes four classes of functions to identify suitable tasks receptive to automation as shown in Table 1.

Table 1 – Four classes of functions identifying tasks suitable for task automation (Adapted from Parasuraman et al. 2000)

Function Class	Criteria
1 - Acquisition of information	The information can be acquired from the devices, objects or other software systems to be automated. To understand whether the task is routine and repetitive.
2 - Analysis of information	The present and future state of devices and objects can be predicted and analysed to understand the change in state of tasks.
3 - Decision action and selection	The augmentation or substitution of human decision making with computer-based automated decision making requires no judgement to make a selection or choice. For example, where conditional logic can prescribe all potential decision choices if a particular known condition arises.
4 - Implementation of action	The human worker decides on what is actually automated compared to what could be automated. For example, a user can decide one of a number of settings on a photocopier. These settings could include: manual stapling, automatic stapling, manual sorting and automatic sorting.

In practice, an organisation would apply the process outlined by Parasuraman et al. (2000) by examining each business task to be considered for automation and identifying whether the task meets the criteria for one or more classes of function. According to this framework, a task that meets all function criterions is thus suitable to some degree of automation. Parasuraman et al.'s (2000) framework was devised for electronic or mechanical automation devices and does not consider software-based automation technologies. Ford (2015) argues that for software-based automation, such as BPAuS technology, a further criterion needed to determine task suitability for automation is whether the task is repetitive and routine. Based on the Parasuraman et al.'s (2000) framework, this criterion is included in the function class "acquisition of information" (see Table 1). For the purposes of this study, the adapted classes listed in Table 1 are used to assess the types of tasks selected for automation.

2.3.2 Level of Automation (LoA)

The second stage is level of automation. In this stage the task that is receptive to automation is considered in terms of the degree the task is performed autonomously. The extent a human is directly involved in supporting the completion of an automated task is termed 'level of automation' (LoA) between human and automation agent (Steels 1995; Wickens et al. 1998 and Vagia et al. 2016). The term is also referred to as 'Degree of Automation' (DoA) (Wickens et al. 2010; Onnasch et al. 2013). There is no unified definition of LoA or DoA (Pacaux-Lemoine and Millot 2016); however, the principle of the taxonomy is that it defines the degree to which the human still has control of the task.

The extent to which the human may be involved in controlling a task is described across a continuum of levels from low to high (Parasuraman et al. 2000). At the low level (usually labelled as level one) the task is manually performed by a human. At the high level the task is fully automated without any human intervention. This is illustrated by Vagia et al. (2016), who undertook a systematic meta-analysis of literature in the use of LoA. The review identified that there was no consistent use of the term 'autonomy' and 'automation', with many studies proposing different LoA taxonomies. The analysis identified that the different range of LoA arise because of the context and domain (Woods 1996) in which the automation is used. For instance Sheridan and Verplank (1978) proposed a range up to ten LoA in their airplane computer software system study, whereas Endsley (1987) proposed a LoA range from one (manual) to four (fully automated) in their avionics study. Draper (1995) proposed a LoA range from one (manual) to five (fully automated) in their manufacturing study. Fereidunian et al. (2007) proposed a LoA range from one (manual) to eleven (fully automated) in their power distribution company study.

Vagia et al. (2016) performed a systematic analysis of how different studies defined levels of automation within their domain. The outcome from the meta-analysis review was the creation of a unified LoA taxonomy that Vagia et al. (2016) stated could be more widely used across many domains. The proposed taxonomy is summarised in Table 2. The study did not undertake any empirical work using the revised taxonomy in order to test whether it is appropriate across different domains.

Table 2 – Taxonomies of Automations (Vagia et al. 2016)

Level of autonomy	**Stage Category**	**Description**
1	Full Manual Control	Human worker does everything - computer offers no assistance
2	Decision proposal stage	The computer offers some decisions to the human worker. The human worker decides and executes.
3	Human decision select stage	The human worker selects one decision (from a range of options) and the computer executes the chosen decision
4	Computer decision select stage	The computer selects one decision (from a range of options) and executes the decision with human worker approval
5	Computer execution and human information stage	The computer executes the selected decision and informs the human worker of its actions
6	Computer execution and on-call human information stage	The computer executes the selected decision and informs the human worker only if asked by the human worker
7	Computer execution and voluntarily information stage	The computer executes the selected decision and informs the human worker only if the computer decides to
8	Autonomous control stage	The computer does everything without human worker notification, except if an unexpected error occurs.

Vagia et al. (2016) proposed a LoA range from one to eight. At the lowest level (level 1) the task is manually performed by a human with no automation of the task. The level increases when some degree of automation is introduced. When the task is fully automated and requires no human intervention or support then the LoA is set at the highest level (level 8). Understanding the level of automation of a task assists with determining the degree the task is automated and the extent human intervention and support may still be required. When considered in the context of software automation, the LoA can be further grouped into three forms: basic form, enhanced form and cognitive intelligent form (Capgemini 2016; Willcocks and Lacity 2016). The basic form of software automation includes the use of computers to deliver office automation. This form includes simple programming instructions such as those found in spreadsheet macros to assist the worker in undertaking specific tasks. The task is typically under the control of the human and therefore is usually considered at automation level 1 or level 2. An enhanced form of automation involves some elements of human and automation interaction. This includes when unexpected conditions arise that require a human to take control. (Smith and Fingar 2003; Daniel et al. 2012; Reijers et al. 2016). BPAuS technology presently falls into this category. The task is usually considered at an automation level between 3 and 7.

In the cognitive intelligent form, the automation agent may adapt to it operating environment. This is described in terms of 'adaptive automation' where the existing level of automation for the automation agent is not fixed and instead changes to a lower level or higher level (refer to column "level of autonomy" in Table 2) depending on the operation situation and the perceived complexity of the task to be performed (Moray et al. 2000; Viagia et al. 2016). This provides an opportunity to dynamically manage the workload between human and computer to achieve the expected outcome (Inagaki 2003; Kaber and Endsley 2004). Adaptive automation has been empirically studied over the past two decades across a number of domains, for instance in semi-autonomous driving vehicles (Parasuraman et al. 2009); secondly, in air traffic control management (Wickens et al. 1998) to manage airplane flight paths; thirdly, in aviation (Layton et al. 1994; Billings 1996) and industrial process management (Cummings 2006) to ensure the automated system can adapt and self-adjust to its operating environment. Adaptive automation requires the use of cognitive and artificial intelligence type of technologies. Whether a task is considered for cognitive automation also depends on the appetite of the organisation to move control and decision making away from a human and have this managed by the automation agent. What to automate and the degree of automation may be guided by opportunities to exploit human strengths and compensate for human susceptibilities as well as to consider the types of tasks receptive to automation (Susskind and Susskind 2015).

For the purposes of this study, the levels of automation listed in Table 2 are used to assess the degree the task is automated and to identify the likely extent human-automation agent interaction may be required to complete the task.

2.3.3 Automation Acceptance

The third stage concerns with understanding the extent to which task automation is accepted and used by a human to ensure the success of the automation and completion of the process. Acceptance is also considered from the context of whether the automation assists the organisation or could pose a risk to the organisation. This is relevant when the degree and extent of any collaboration between human and automation agent requires the human to accept and work with the automated agent and to take control of the situation if the automation fails. Literature typically considers this stage separately and independently from the other two stages of automation design described in the previous sections.

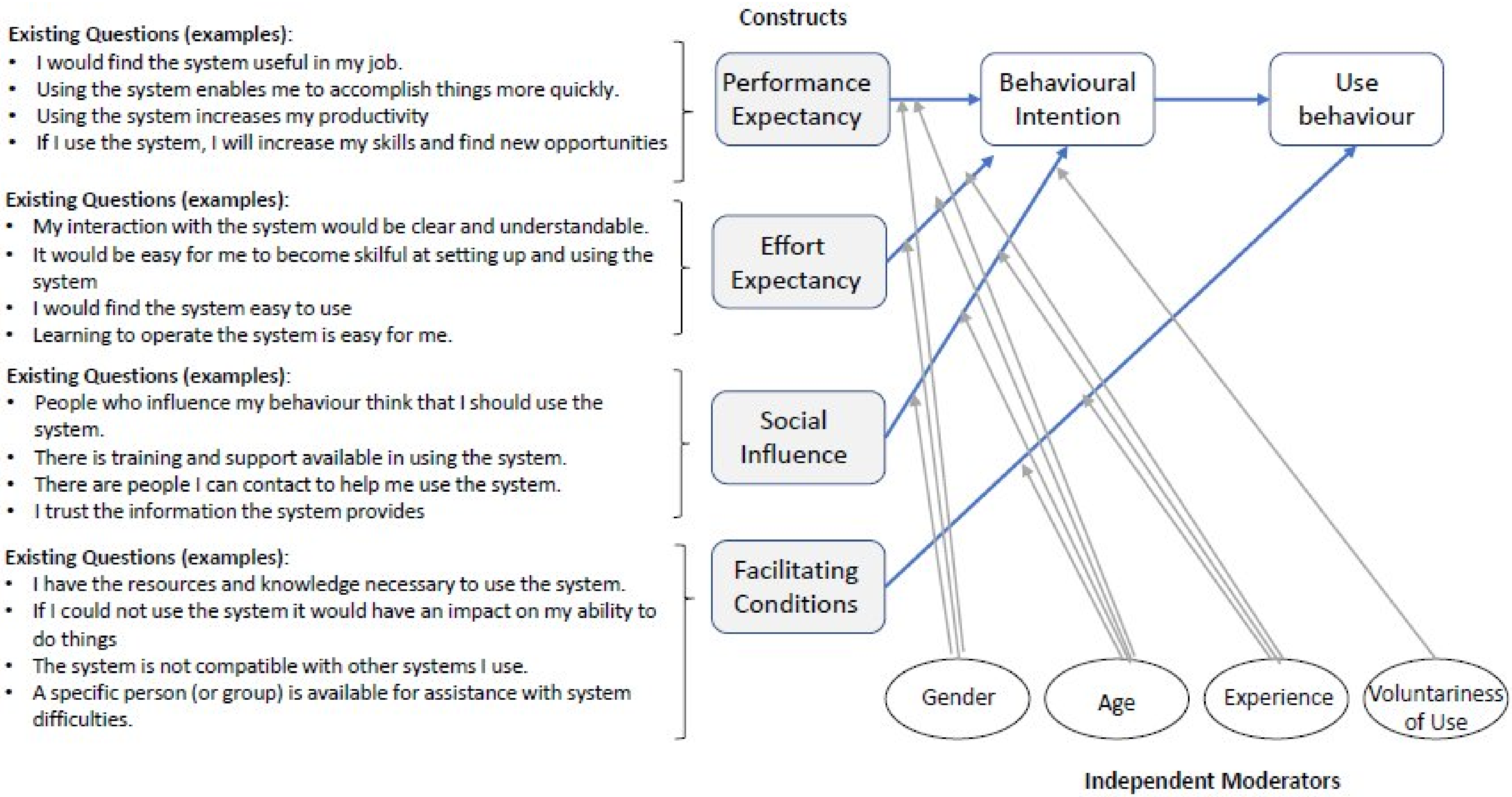
Over 40 theoretical models and frameworks, developed over several decades, have been suggested to understand human intentions to use technology (Keil et al. 1995; Endsley and Kaber 1999; Venkatesh et al. 2003; Lewis 2012; Alaiad and Zhou 2014). These models explore workers' attitudes and behavioural intentions to use a broad range of technologies in a wide range of settings, for instance, the organisation, workplace and social environments. The large number of models poses a further challenge. In an effort to unify the models, Venkatesh et al. (2003) reviewed eight technology acceptance models and undertook a longitudinal study to understand similarities, strengths and weaknesses. As a result, they proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) model. UTAUT postulates that three constructs (performance expectancy, effort expectancy and social influence) are direct determinants of behavioural intentions to use information technology. The behavioural intentions combined with a fourth construct (facilitating conditions) is argued to provide a useful tool to assess the likelihood of success for a new technology (Venkatesh et al. 2003; Williams et al. 2011). The four constructs are summarised in Table 3. Venkatesh et al. (2003) developed a set of questions to test each construct, the relationship between the constructs and the use of the moderators. In addition to the four constructs, the model postulates that one or more of the four independent moderators (gender, age, experience and voluntariness of use) may be factors influencing behaviour and use intentions against one or more of the constructs, see Figure 2.

Table 3 – UTAUT Model - direct factors of usage behaviour and intentions (Venkatesh et al. 2003)

Constructs	Description
1) Performance expectancy	The extent to which an individual perceives that using a technology will enhance his/her productivity and therefore lead to performance gains
2) Effort expectancy	The extent to which using a system is free from effort, i.e. perceived ease of use
3) Social influence	The extent to which an individual perceives the importance other people believe he/she should or should not perform the behaviour in question. Also conceptualised as subjective norms, normative beliefs (Vijayasarathy, 2004), and social norms (Hsu and Lu, 2004)
4) Facilitating conditions	The perception regarding availability of organisation and supporting resources, including infrastructure to support the use of the innovation (Sun and Jeyaraj 2013).

Venkatesh et al. (2003) argue that the model can explain up to 70% of the intentions to use technology. UTAUT and variations of the model (with and without gender, age, experience and voluntariness) has been extensively applied in empirical studies over the past decade. Several authors (Dwivedi et al. 2011; Williams et al. 2011; Taiwo and Downe 2013) have undertaken meta-analysis reviews of studies citing UTAUT to harmonise the empirical evidence. An analysis of these findings across over 500 studies identified that only one study investigated office administration systems (for instance word processor, spreadsheet, database programs). The reason for this is not clearly elucidated, however, the use of UTAUT models is observed more frequently with technology devices, for instance laptop devices and digital services, for instance use of internet sites and software applications. Few studies have used UTAUT to explain the acceptance and application of the new wave of software automation technologies, for instance BPAuS. For the purposes of this study the UTAUT model is not empirically tested, instead the model is explored to assess whether it captures the key elements to evaluate worker's intention to adopt and use BPAuS technology.

Figure 2 – Structure of UTAUT model (Venkatesh et al. 2003)



The next section explores the new wave of technology labelled BPAuS and examines how the three stages of automation design discussed in Section 2.3 could be applied. It also explores any additional consideration that may be necessary to support the understanding of human and BPAuS interaction.

2.4 Impact of Software Process Automation Technology

Since 2014 another strand of technology-driven automation has started to emerge using software tools. Software-based automation technology is not new and has existed for a number of decades in different forms and pretexts (Willcocks et al. 2015). This includes decision support systems, banking systems (for instance automated teller machine cash dispensers that use software to control the machines activities), and vehicle and airplane automation devices that use intelligent software application to control the devices. What is new is the use of the automation technology, known as BPAuS. BPAuS is characterised by the use of software based technology to automate tasks, also referred to as 'software robot' (Lacity et al. 2015b) and 'software agent' (Gaonkar 2020; Muthusamy et al. 2020), that extends the workforce team by creating a virtual digital workforce (Donnellan 2017). The aim is to replicate and improve on the repetitive, routine business process task performed by a human worker using a computer workstation. The assertion is that any business process task that a person can perform that meets certain characteristics could be automated. The characteristics include: tasks that are repetitive; tasks requiring limited or no judgement (i.e. are predominantly predictable); and tasks undertaken using software applications from a computer workstation (see Table 1).

In a hospital environment BPAuS has been implemented in a number of settings. One of these is in the patient booking-in kiosk (Blue Prism 2020) where patient details are validated, allotted appointment confirmed and changes are then made to their appointment schedule. In the case of NHS Wales, process automation has been implemented to scan paper-based prescription and invoice documents (NWSSP Primary Care Services, 2021) and pay suppliers automatically. This is achieved through the scanning of the documents to create digital images and then to use character recognition software which intelligently 'reads' the data required from the images, for instance supplier name, amount, payee details to then store the extracted data into the Financial system. The Finance system then pays the supplier using an automated Payment system. The only time a human worker has to intervene is to manually enter the data when the software is not able to correctly read the data it requires from the image.

BPAuS is in its early stages of potential adoption across the service sector in many industries, such as telecommunication, energy, financial services and healthcare (Enriquez et al. 2020). In the service sector Willcocks and Lacity (2016) term this as 'Service Automation' and expect that the impact of BPAuS on organisations will be similar to other forms of automation technologies, although further research is required to explore this. One of the expected benefits of BPAuS is to reduce the costs of clerical and administrative tasks through increasing the volume of tasks performed and transactions processed, whilst reducing error rates through greater consistent controls. This is argued to enable managers and the organisation to gain increased control of their business operations (Olson and Lucas 1982; Coombs and Jonsson 1991; Smith et al. 1996).

Since 2017 an enhanced form of BPAuS technology has started to emerge that extends the existing process automation capability to include the ability for the technology to apply some form of intelligence through the use of AI and machine learning capabilities built into the technology. A number of empirical studies have started to explore the capability of the combined BPAuS and AI technologies (Lamberton et al. 2017; Khramov 2018; Kopec et al. 2018; Mendling et al. 2018). These include delivering tailored personalised medicine and managing business processes that are less routine and more complex.

BPAuS technologies have only recently started to be empirically studied, with limited information presently available to understand the impact on jobs, skills and work characteristics and how this compares to other forms of automation technologies (see Section 2.2.2). There is an absence of studies testing BPAuS technology against existing theoretical models and frameworks. There are also gaps in the literature on the challenges and consequences of the technology and how this compares to other forms of automation technologies (see Section 2.2.3). Some studies (Lacity et al. 2015b; Syed et al. 2020) report that one of the challenges with BPAuS technology is the speed constraint of the IT applications that BPAuS is “controlling”. This is particularly the case for legacy IT applications that may run at a slower rate on old technology infrastructure. Therefore, if high volumes of repetitive tasks are to be processed in a very short timescale then these tasks may not be best suited for BPAuS when controlling some types of IT applications. BPAuS has proliferated on the expectation that it can either complement the workforce by automating some tasks to improve workers’ productivity and deliver new services with the same number of workers (Willcocks and Lacity 2016; Kaya et al. 2019) or substituting the worker to reduce costs and increase throughput (Deloitte 2015; Deloitte 2017; Uskenbayeva et al. 2019). The studies did not explore employment loss. Recent studies (Willcocks and Lacity 2016; Enriquez et al. 2020) suggest that the success and use of BPAuS is dependent on understanding the extent human-automation collaboration will be required and the nature of the controls to ensure all tasks are completed. These considerations for BPAuS technology are explored in the next section.

2.4.1 Human-Software Agent Interaction

Existing frameworks and models that explore human-automation agent interaction, in particular the proposed three stages of automation design (see Figure 1) have not been applied to BPAuS technology. The stages could assist with understanding whether the task is receptive to automation, level of automation delivered and whether the UTAUT model explains the acceptance to adopt and use BPAuS technology. For the purposes of this study, the adapted Parasuraman et al. (2000) framework that combines all three stages of automation design is used to explore whether collectively this improves the understanding of the tasks to automate using BPAuS technology, the interactions that exist between human worker and automation and to understand workers’ attitudes to work with BPAuS technology. Although the adapted Parasuraman et al. (2000) framework provides considerations for individual tasks to be automated, it does not address the interaction or convergence between several tasks that are performed as a series of links in the chain to complete the business process (Autor 2017). In these cases, some tasks may be performed by automation agents and others still performed by human workers. Parasuraman et al. (2000) adapted framework (Figure 1) is extended to illustrate the relationship between two tasks in a process chain, shown in Figure 3, with the three stages of automation design considered against each task (task

'A' and task 'B'). The relationship between the tasks is defined in terms of what Kaplinsky (1985) describes as the 'sphere of automation' (see Section 2.4.2).

Figure 3 – Spheres of automation conceptual framework
(Adapted from Parasuraman et al. 2000)

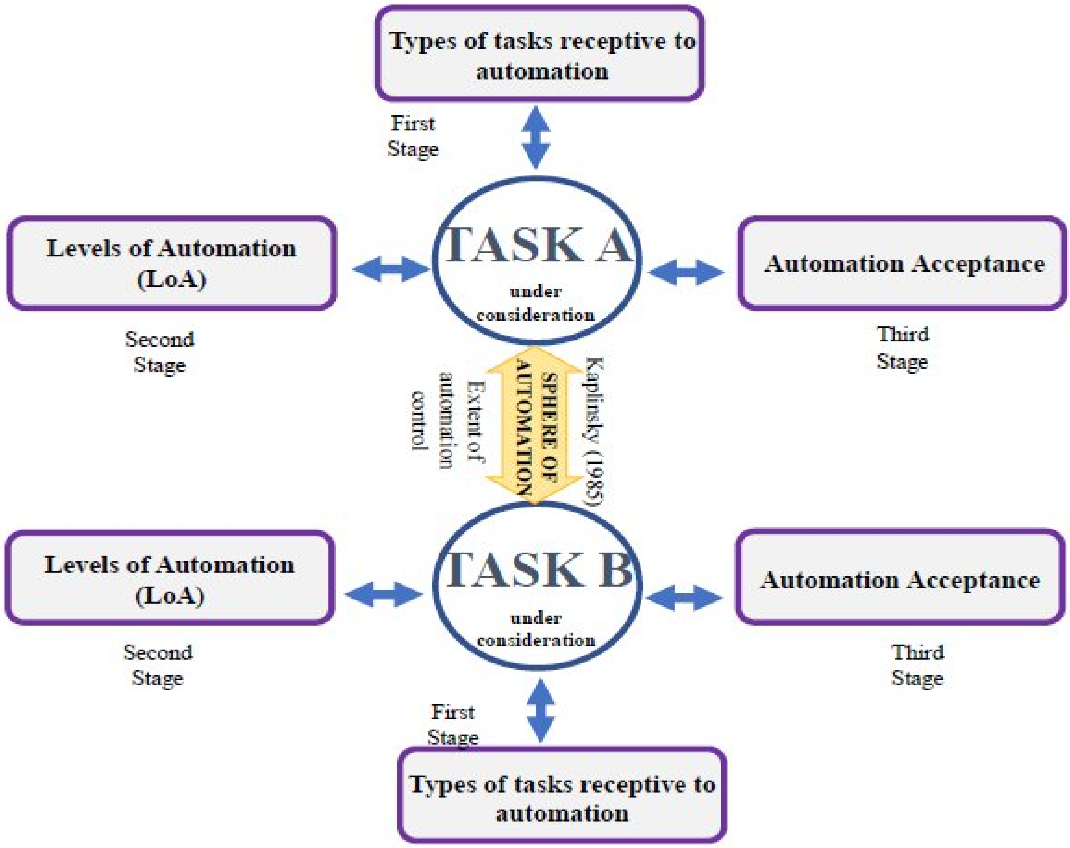
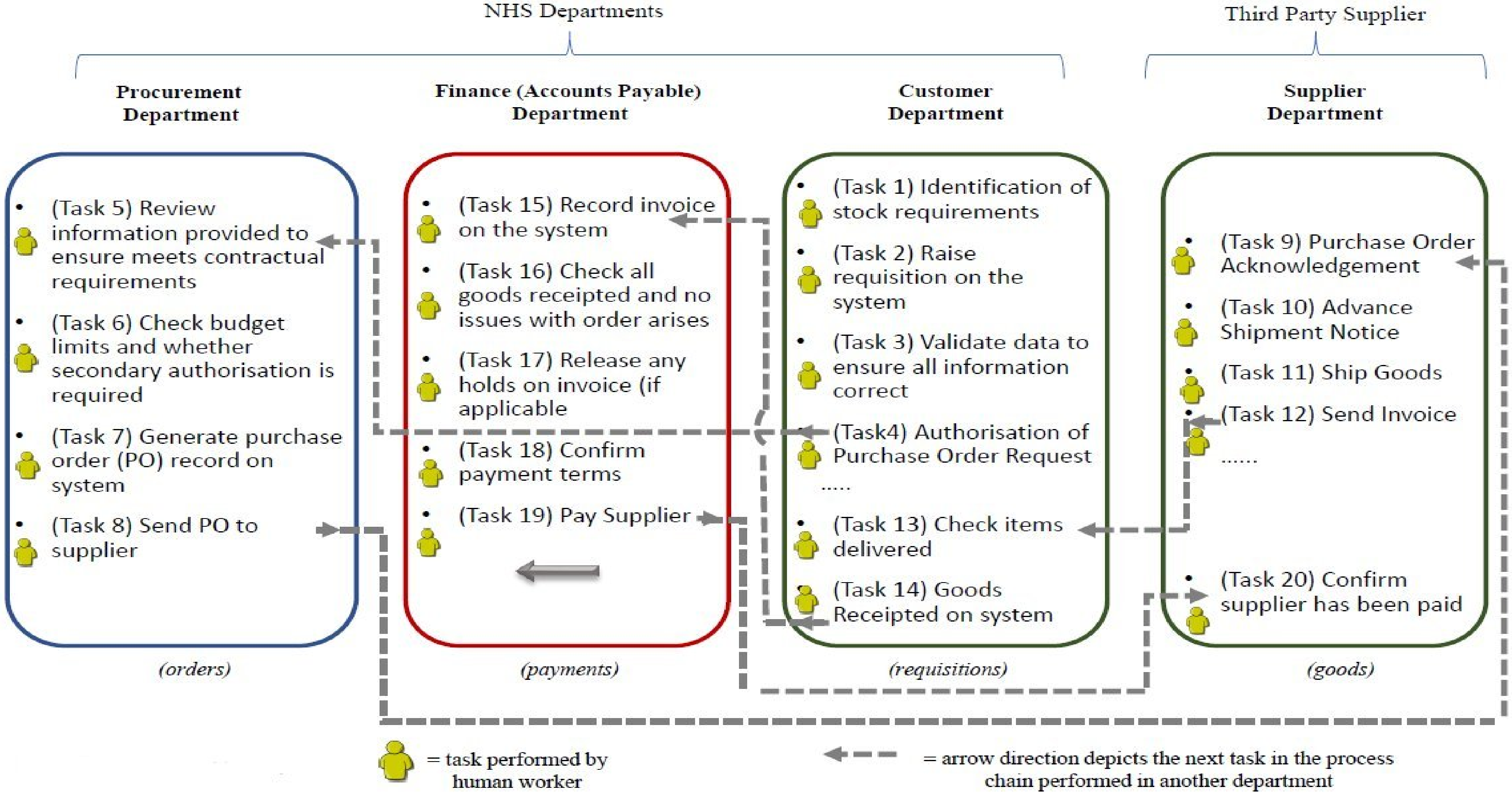


Figure 4 provides an example of how the adapted Parasuraman et al. (2000) framework illustrated in Figure 3 can be used. The example relates to raising orders with suppliers and paying invoices, described as the Procure to Pay (P2P) business process lifecycle. In the P2P lifecycle illustration, the end-to-end process chain comprises 20 tasks, commencing at task 1 and finishes at task 20, that are performed by people in the chain across a number of organisation departments. A human worker in the Customer department is responsible for raising requisition for goods and services to suppliers (tasks 1 to 4). A separate person in the Procurement department may be responsible for reviewing the requisitions, grouping similar requisition requests across the organisation into a single order to the supplier (tasks 5 to 8). A further person in the Customer department may be responsible for receiving the goods into the organisation (business tasks 13 and 14).

Figure 4 – Depiction of Procure to Pay process chain



A person in the Finance department processes the supplier invoices, ensuring only those invoices where the goods or services have been delivered to the Customer department are paid to the supplier (tasks 15 to 19). The person in the Supplier department will be responsible for confirming that they have received the order, processing the request, shipping the goods and then sending the invoice (tasks 9 to 12). The supplier will then check that they have been paid within the payment terms (task 20). This example comprises of tasks undertaken by different job roles (Customer department, Finance department, Procurement department and Supplier department). The first role (raising the requisition) may be performed by the Customer department, the second role (placing the order with the supplier) may be performed by the Procurement department, with the payment of the invoices role performed by the Finance department.

In the P2P process chain illustration, in Figure 4, the assessment of each task against the three stages of automation design set out in the adapted Parasuraman et al. (2000) framework (Figure 1) will be a list of tasks to be automated to some degree and a list of tasks still to be performed by a human. If an automated agent cannot perform all the tasks in the process then some form of human control will still be required. Over many decades, the role of the human in supporting automation agents has been debated (Grote et al. 2014) and some studies have explored whether automation should be designed around the human. The degree and extent of any collaboration between human and automation agent is described in terms of human-centred automation (Young et al. 2007; Kumar et al. 2019). This infers that any automated process and task is designed and implemented around the human worker. With human-centred automation, the human is able to take control and intervene when necessary. The principle places the human at the forefront of any proposed automation activity (for instance in surgical procedures using automation agents). This is to ensure system predictability, transparency, accountability and appropriate control exists to achieve the required process outcomes (Yi and Hwang 2003; Sanders et al. 2011; Grote et al. 2014).

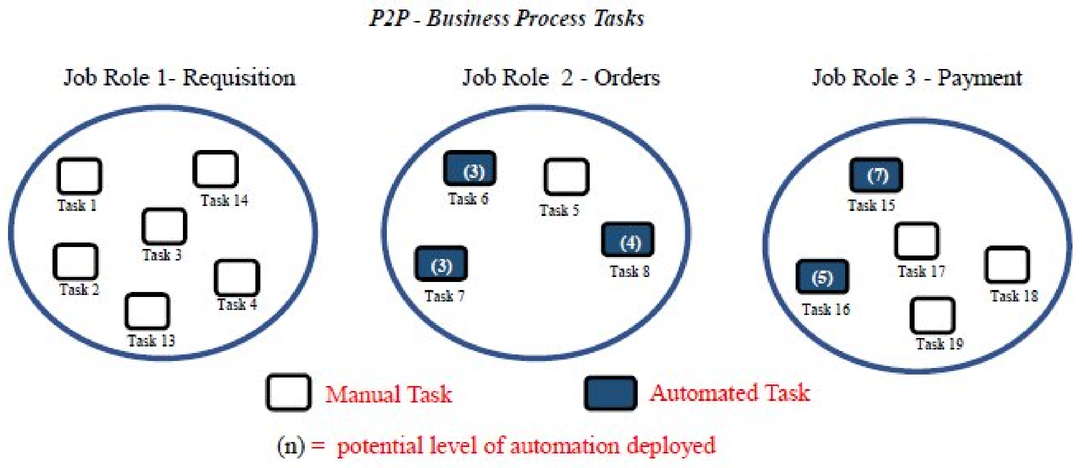
To understand whether automation needs to be designed around the human, with the human controlling the completion of the process, it is necessary to evaluate the relationship between each automated task and whether this gives rise to tasks potentially coalescing into a single enlarged automated task or remain as discreet units of work (i.e. tasks). Tasks coalescing into a single enlarged automated task may be considered when a number of adjacent tasks operate autonomously at Level of Automation (LoA) level 8, refer to Table 2 (page 29) and therefore do not require any human control in the automation design. In all other situations (i.e. tasks operating at LoA level 7 or lower), the tasks may require some form of human control to be considered in the automation design. This assessment is described in terms of the sphere of automation (Kaplinsky 1985). Kaplinsky (1985) proposed a model that categorises automation controls for a business process, the model is explored in the next section.

2.4.2 Spheres of Automation Control

To assess the extent an organisation has proposed to automate one or more tasks and the scope of any human control that must exist between each automated task, Kaplinsky (1985) proposed three types of automation controls: intra-activity; intra-sphere; and inter-sphere. These controls are important in understanding the extent of any human-software agent interaction and human control that may still be required post-automation to ensure all tasks in the chain can be successfully completed. Kaplinsky (1985) describes the model from the context of a manufacturing production setting and uses it to explain the extent an organisation has automated its tasks. For the purposes of this study, the Kaplinsky (1985) model can be adapted to workplace process tasks performed using BPAuS technology.

The intra-activity automation control illustrated in Figure 5 refers to individual tasks in a job role being performed in isolation from the other tasks that form part of the business process. It is within the intra-activity sphere that an organisation may first look to automate some of its tasks by applying the adapted Parasuraman et al. (2000) framework (Figure 1). The tasks may be manual (e.g. task 5 in orders) or automated (e.g. task 6 in orders) but they are performed separately as a discreet unit of work. Kaplinsky (1985) does not explore the degree an activity is automated as proposed by Vagia et al. (2016) (see Table 2). However, Figure 5 illustrates some potential LoA numbers (i.e. 3 or greater) that could arise for each automated task in the order and payment job roles (e.g. task 8 in orders and task 15 in payment). The remaining tasks in each of the job roles (e.g. task 18 in payments) continue to be performed by a human worker. In this illustration, although tasks may be defined as automated, the tasks are really semi-autonomous because they are not performing at LoA level 8 (fully automated). Consequently the software agent will have to collaborate with the human worker, with the worker remaining at the centre of the automation design to oversee each task and ensure the entire process completes successfully.

Figure 5 – Intra-Activity Automation (Adapted from Kaplinksy 1985)



The intra-sphere is the second type of automation control (shown in Figure 6), where the LoA being achieved for automated tasks requires minimum human intervention. In turn, allowing separate automated tasks within a particular job role (or process) to collaborate to form a combined set of correlated tasks. This is claimed would enable an organisation to further reduce reliance on the human worker, increase transaction throughput and reduce human errors (Bates et al. 2001; Deloitte 2015). For instance, in the P2P business process cycle, in the ‘job role 2 orders’, the checking of the budget limits, the creation of the purchase order and transmission to the supplier (tasks 6 to 8) may be managed by software agents as illustrated with a LoA at level 6 (see Table 2). In this illustration, the software agent completes tasks 6 to 8 and only engages with a human worker if an unexpected error occurs or if the computer decides to. There is no need for the worker to manage the individual tasks or manage the control between one task and the next task. However, since the tasks is not fully automated (i.e. LoA level

8) then the worker would still need to remain at the centre of the automation design to oversee the entire process and ensure it completes successfully. This will need to be considered in terms of the level of integration between the automation tasks and the worker tasks (Gouvea da Costa et al. 1998) and how activities are passed across multiple tasks (some performed by workers and others by software agents) to complete the process.

Figure 6 – Intra-Sphere Automation (Adapted from Kaplinksy 1985)

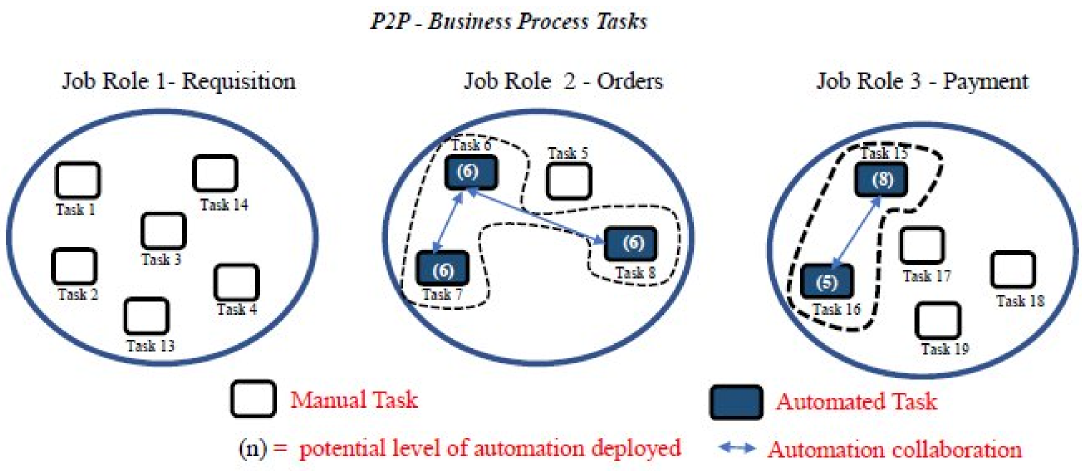
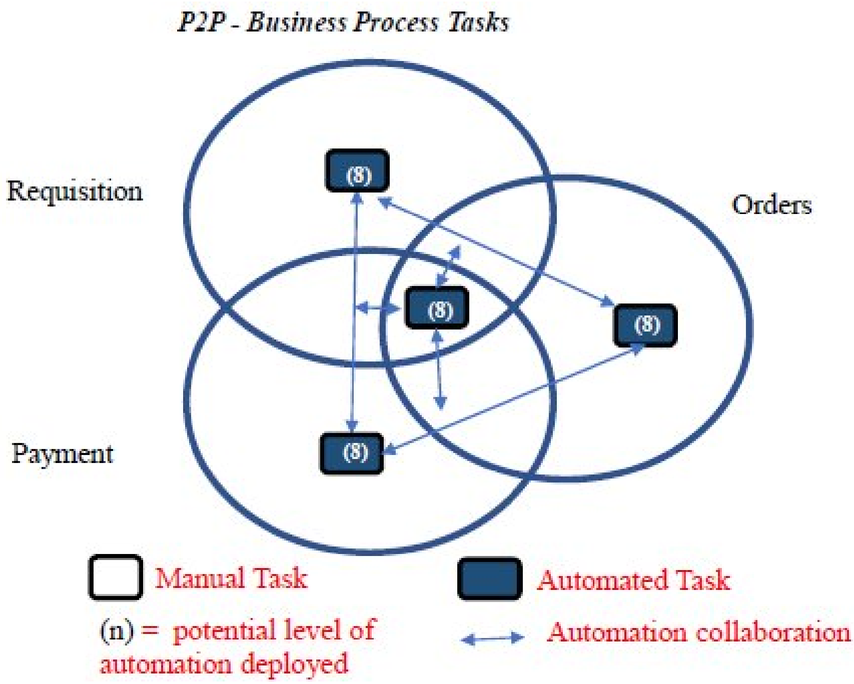


Figure 7 illustrates inter-sphere automation where the separate automated tasks or groups of tasks in different job roles are integrated. The objective of this stage is to fully automate all the human worker tasks (at LoA level 8) across all relevant job role processes. This is to ensure no manual intervention or human worker control is required to complete the business process. For instance, in the P2P business process lifecycle, a software agent controller (as presented in the centre interconnecting cell in Figure 7) may operate across all the job roles and business processes.

The software agent controller directs which software agent in each job role process is to perform its tasks. The software agent in each job role undertakes all the tasks without the need to interact with a human worker (based on the LoA at level 8). For example, in the requisition process, all the requisition requests received from the requestor are validated, the requisition created and forwarded onto the ordering process. Separately the software agent would process the supplier's invoice, validating the data against the order raised before authorising the invoice for payment. In this illustration, the human worker does not need to be considered in the automation design.

Figure 7 – Inter-Sphere Automation (Adapted from Kaplinksy 1985)



This study uses the adapted Parasuraman et al. (2000) framework (see Figure 1) and the Kaplinksy (1985) model to understand what is likely to lead to automation success using BPAuS technology, in particular the selection of tasks to be automated, the collaboration required between the automation and human worker and whether human control is still required to manage the completion of the process. Using the adapted Parasuraman et al. (2000) framework and the Kaplinksy (1985) model will assist in exploring the impact of automation on jobs, skills and work characteristics.

2.5 Research Questions

A review of the literature has identified gaps in the understanding of the impact and consequences of BPAuS technologies and the different taxonomies of automation on jobs, skills and work characteristics. There are considerably fewer studies within the domain of the healthcare sector than in the telecommunication, energy and financial service sectors. There is a lack of research on whether adapting existing frameworks such as Parasuraman et al. (2000) can help to explain the selection of automation tasks, the level of automation implemented and whether workers have a choice about whether to interact with the BPAuS technology. A further gap in literature is whether models such as Kaplinksy (1985) contribute to an explanation of whether humans are placed at the forefront of any proposed automation activity design and provides similar challenges and opportunities that exist for other forms of automation technologies.

The aim of the study is to address three Research Questions (RQ): RQ1, what are the main determinants that influence the deployment of BPAuS technology in an NHS workplace setting and can decisions be explained through existing frameworks and models; RQ2, how does the use of BPAuS technology affect job characteristics (task variety, responsibilities and job demands), skills characteristics (job complexity, qualifications and skills) and work characteristics (challenges, resources, output and outcomes); and RQ3, to what extent does the Unified Theory of Acceptance and Use of Technology (UTAUT) model captures the key elements to assess workers' intention to adopt and use BPAuS technology.

The research questions will be explored from the context of the healthcare sector in Wales and a number of workplace settings where BPAuS technology was being considered.

2.6 Conclusion

The review of literature reveals there has been a long-standing interest in understanding the consequences of task automation in the workplace. What is less well covered are the drawbacks of the automation on organisations and workers. There is a considerable volume of studies exploring the taxonomies of automation and setting this in the context of different categories of agents. A number of these studies highlight some of the challenges and consequences identified with automation. The literature review also reveals a broad range of theories and frameworks that attempt to represent the impact of automation on workers and skill sets.

Existing literature on human-automation interaction explores two of the proposed three stages of automation design (types of tasks receptive to automation and level of automation). The third stage of design (automation acceptance) is an important consideration to understand whether the UTAUT model capture the key elements to evaluate workers' intention to work with BPAuS technology. This study applies all three stages of automation design together and considers whether the adapted Parasuraman et al. (2000) framework contributes to the understanding of tasks suitable for automation and the extent of the interaction required between human worker and the automation when applied to BPAuS technology. The study also applies the Kaplinksy (1985) model to understand whether humans are placed at the forefront of any proposed automation design. This is particularly important where full automation is not delivered. This more comprehensive approach aims to uncover whether the challenges and consequences facing other forms of automation technologies also extends to the new BPAuS technologies. In particular, what is likely to lead to automation success and what is the impact on jobs, skills and work characteristics.

Chapter Three: Research Methodology

3.1 Introduction

This thesis explores a new wave of software-based automation technology referred to as BPAuS, where the number of empirical studies in academic automation literature is small (Bennie et al. 2013; Willcocks and Lacity 2016). The nature of the research problem is concerned with analysing a real-world contemporary phenomenon in a natural context rather than developing normative decision models to predict and control a situation to then understand what works and what does not work (McElroy 1982; Yin 2012). The study involves taking a naturalistic approach to data gathering, adopting an interpretivist stance to explore the intervention (Glaser and Strauss 1967; Suddaby 2006; Corbin and Strauss 2008).

To address the three research questions (see Section 2.5) a qualitative study was undertaken. Whilst recognising strengths and weaknesses of other design approaches, such as experiment, survey, document analysis, historical study, observation and logic modelling, my research uses a multiple case study design. The research design is described and justified in Section 3.2. To gather the data required to understand the facets of the phenomenon as stated in the ontological position, semi-structured interviews and self-administered questionnaires were used. The reason for the methods is described in Section 3.3. Details of the research sites and participants involved in the study are given in Section 3.4. Details on how the data was unpacked, structured and analysed are set out in Section 3.5. The ethical considerations and approval sought is presented in Section 3.6, with reflection on my position in the study as an insider detailed in Section 3.7. The limitations of the research are described in Section 3.8 and this is followed by concluding remarks in Section 3.9.

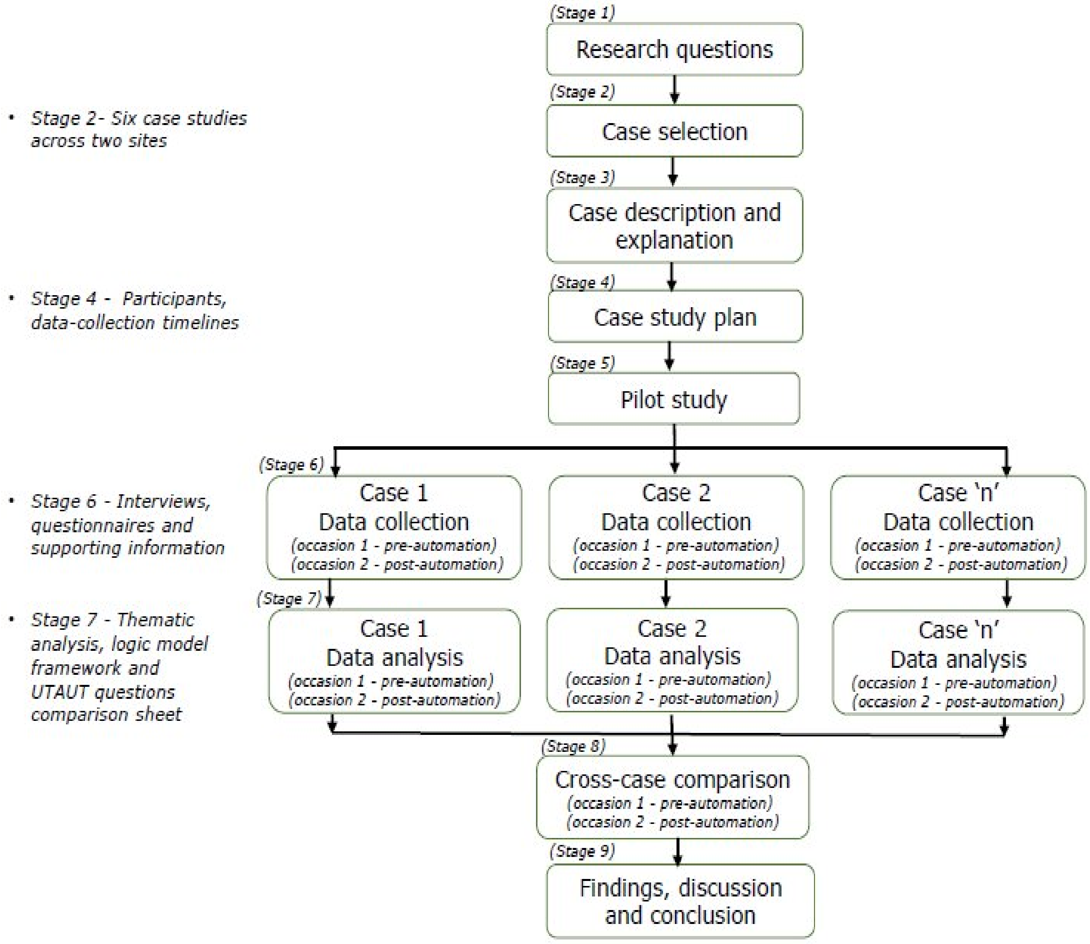
3.2 Research Design

The nature of the research questions is the key factor in determining which research design approach is the most appropriate (Wilkinson and Birmingham 2003; Yin 2014). Both qualitative and quantitative methodologies have strengths and weaknesses and these often invoke paradigm wars and philosophical debate among the supporters and opponents of different approaches (Gephart 2004; Onwuegbuzie and Leech 2006;

Finlay 2012). To make a decision that one approach is better than the other underestimates the complexity, richness, and varied traditions/disciplines underlying each approach (Robson 2002). There is a tendency to associate research problems concerned with analysis of a real-world contemporary phenomenon in a natural setting with qualitative case study design (Baxter and Jack 2008; Yin 2014; Bryman 2016).

A multi-case study qualitative design was chosen to provide greater robustness to the findings by allowing for more varied evidence in the use of BPAuS technologies to be considered across a number of different locations (Teegavarapu and Summers 2008; Yin 2014). The approach also enabled comparison across case studies, engaging in a theoretical and synthetical analysis of “similarities, differences and patterns” (Rowley 2002; Goodrick, 2014, p.1). The use of multiple case studies also aimed to address the criticisms of case study design. One of these is that findings derived from a single case cannot be generalised and therefore cannot contribute to scientific development (Giddens 1984). However, Flyvbjerg (2006) argues that the same criticism could apply to alternative methods as well, and that case study as a supplement or alternative to other methods may be central to scientific development, for instance “falsification” (Popper 1959) studies.   A second criticism is that a case study provides more room for the researcher’s subjectivity and preconceived notions (Diamond 1996).   Yin (2014) argues that the use of data from multiple sources of evidence can help limit bias induced by a researcher’s subjectivity. According to Campbell (1975) and Rose et al. (2015) case studies have their own rigour, allowing the revision of hypotheses due to mistaken preconceived assumptions, concepts or views.   A third criticism is that case studies contain substantial narratives that may be difficult to summarise into scientific formula and develop general propositions and theories (Mitchell and Charmaz, 1996, White, 1990).   Flyvbjerg (2006:241) argues that it is not necessary to summarise case studies because the problem being studied may be complex and that good case studies should be “read as narratives in their entirety”. The nine stages in the multiple case design approach used is depicted at Figure 8.

Figure 8 - Multiple case design (Adapted from Rose et al. 2015)



The design was seen as a rigorous way of making sense of the complex behavioural conditions, richness, depth and any nuances (Mason 2002; Wahyuni 2012) that would be generated using an individual's own subjective experience and background. For this study, an explanatory framework approach was used for each case study analysis (Ghauri 2004). The approach involves identifying relevant cases (see Section 3.4) that address the research questions (stage 2). For each case, the reason for the selection is explained (stage 3), including the situation at the site and the business process being considered for automation. This is followed by a plan detailing what the study is intending to achieve and how (stage 4), linking the research questions with the data needed to answer the questions and the timeline to collect the data. To provide robustness to the exercise, the plan, together with the interview questions and questionnaires is tested (stage 5).The next stage is the uniform data collection for the individual case studies (stage 6) and then data analysis (stage 7), with data collected and analysed on two occasions: the first occasion explored the workers' environment (job, work and skills characteristics) and the business process where the BPAuS

technology was being considered. This occasion is referred to as the pre-automation phase of the study. The second occasion explored the environment once the BPAuS technology was deployed or where the automation moved into abeyance. This occasion is referred to as the post-automation phase or automation in abeyance phase, depending on whether the automation was implemented. The next stage is the data comparison across all the pre-automation cases and then across all the post-automation cases (stage 8), followed by the findings, discussion and concluding remarks (stage 9).
The flexible nature of case studies lends it to be used with multiple data collection sources (Zainal 2007; Cruzes et al. 2014; Yin 2014). The data collection sources used for this study were semi-structured interviews, questionnaires and internal documents (for example standard operating procedures, process maps and work instructions). The methods are discussed further in Section 3.3.

To understand any meaningful change on the workers, there was a pre and post-automation phase to the study to allow time for the technology to bed into the department and to perform the workers' tasks. There are no fixed time intervals that must be used for pre and post-automation phases of studies; Epitropaki and Robin (2005) argue that it depends on the nature and objective of the study. The post-automation phase for this study reflects the period from when the technology was fully implemented and when the data collection commenced. The term 'fully implemented' referred to when the technology was tasked with processing all the transaction data it was expected to handle. The time interval between when the technology was initially deployed, for instance to test the automation with a small subset of data, and when technology was fully implemented was at least three months. The dates when the data collection exercise could commence for each phase was driven by the department manager at each site and by the development team building the BPAuS technology for the site. The post-automation phase of data collection was driven by the date the technology settled into the process and work environment.

The case study finding chapters details the sites that successfully implemented the automation before the sites that moved their automation into abeyance. This chronological order was to make it easier to compare and contrast the findings across the sites with similar outcomes.

3.3 Research Method

Multiple data sources were used for each case study. Each case used semi-structured interviews and questionnaires to understand people views, interpretation and perceptions to allow multiple facets of a phenomenon to be explored. At each site, interviews were undertaken with participants (a manager and workers) involved in the business process to be automated. Interview questions and questionnaires were designed to reflect whether the participant was a manager or worker. This was to ensure the questions were relevant to the participant role in the process. Internal documents (e.g. process maps, standard operating procedures) were used to provide supplementary information to the data collected from the interviews and questionnaires.

There are a number of research methods and associated instruments than can be applied in research studies (Reichardt and Rallis 1994; Sale et al. 2002; Flick 2009; Tulu, 2010; Lynch 2014). These include interviews, questionnaires and observation. Semi-structured interviews were chosen for three main reasons. First, semi-structured interviews are well suited to explore a complex situation by talking and listening to participants to ensure the details of a situation is understood in the context of the research questions. Secondly, they allow the probing of answers to expand on issues, and the points raised to validate and test the richness of the participants' accounts and their experiences (Gibson 1998; Smith et al. 2009) whilst supporting the understanding of nuances and reducing any ambiguities in the participants' response (Tellis 1997). Thirdly, they provide free dialogue with participants, allowing them to verbalise their thoughts and develop their opinions about the answers they provide, without prejudicing the response. A noted drawback of semi-structured interviews is that it requires experienced interviewers with the skills to ask prompt questions (Kajornboon 2005). Questionnaires were chosen because they allowed for questions that required participants' time to prepare their response, to be administered in advance. This allowed participants to complete the questions in their own time when it was convenient to them, for instance, questions about the time and effort spent over a month to manually perform the tasks to be automated. Questionnaires were easier to administer and can produce data that is simple to interpret if well designed and executed. Questionnaires can be challenging to design and analyse (Wilkinson and

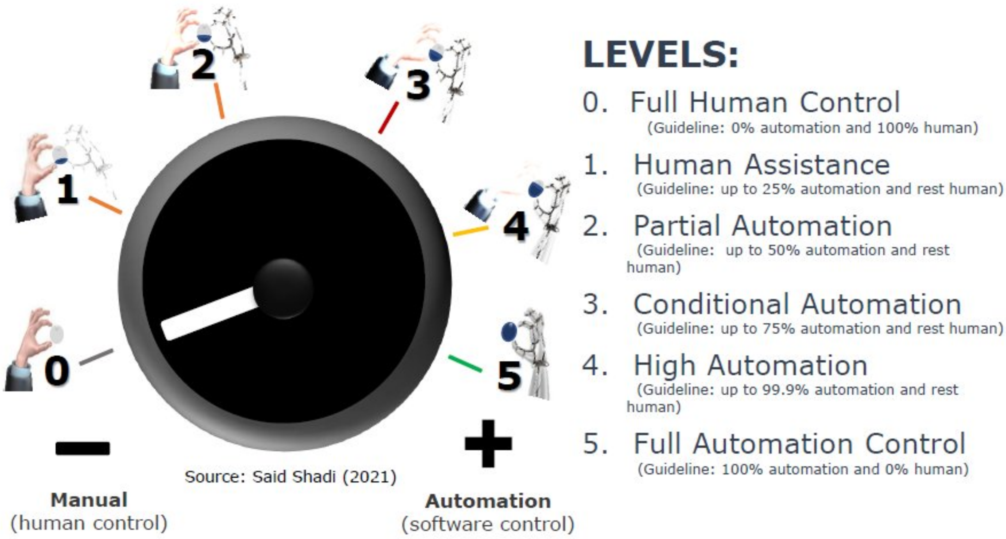
Birmingham 2003) and they do not permit probing of questions, with a greater risk of missing key insight. To address these challenges, the participants' questionnaire responses were reviewed during the interview, to allow the researcher to probe further and to ensure the researcher correctly interpreted the responses. The researcher has previous field experience of conducting semi-structured interviews and designing questionnaires. The existing skills together with piloting the interview questions and questionnaires were expected to reduce any drawback with using interviews and questionnaires.

The interview schedules (see Appendix A) were developed following an extensive review of the literature, and the researcher's prior knowledge of the domain area. The first two research questions (see Section 2.5) needed to use a naturalistic approach to data gathering and therefore mainly broad open questions were used to allow for a range of detailed responses. Where a participant's response required further probing then follow-up questions were asked. This allowed participants the opportunity to discuss their views and experiences without being restricted (Kitchenham and Pfleeger 2002). It was important to reduce the burden on participant's time and impact on their work schedule by ensuring the duration of each interview was kept to the minimum needed. To limit the interview length, self-administered questionnaires (see Appendix B) were also used to ask managers and workers a number of open and closed questions where it was necessary for the participant to have sufficient time to prepare a relevant response. For example, one of the questions asked about the resource effort needed to perform the present tasks. Another question asked about what documentation existed about the tasks, for instance process maps, work instructions and training guides and whether these could be shared with the researcher. These documents provided additional set of data sources to consider in the analysis of the manual process activities. Questionnaires allowed participants to complete the questions when it was convenient for them.

Initially two sets of research interview and questionnaire questions were constructed, one for the pre-automation phase and one for post-automation. The questions were constructed to be addressed by either a manager or worker, with sign-posting in the interview questions when a question was specifically for a manager or worker. A third set of semi-structured questions became necessary during the fieldwork because at two case study sites, the implementation of BPAuS technology moved into abeyance. This was unexpected and it was important to understand the reasons for the decision. This required a specific set of questions to be constructed for managers to address.

The pre-automation questions required participants to describe the present situation in relation to the work and the manual tasks performed. The specific focus was on the job characteristics (task variety, responsibilities and job demands), skills characteristics (job complexity, qualifications, skills) and work characteristics (challenges, resources, output and outcomes). The questions asked participants to explain the reasons for automating the tasks and what benefits the automation was expected to deliver. This included the use of a diagram and description sheet (see Appendix C, Section C2) with different levels of automation as illustrated in Figure 9. Probing questions were used to encourage participants to discuss their feelings about the proposed automation and to clarify and explain their answers.

Figure 9 – BPAuS 5 levels of automation model



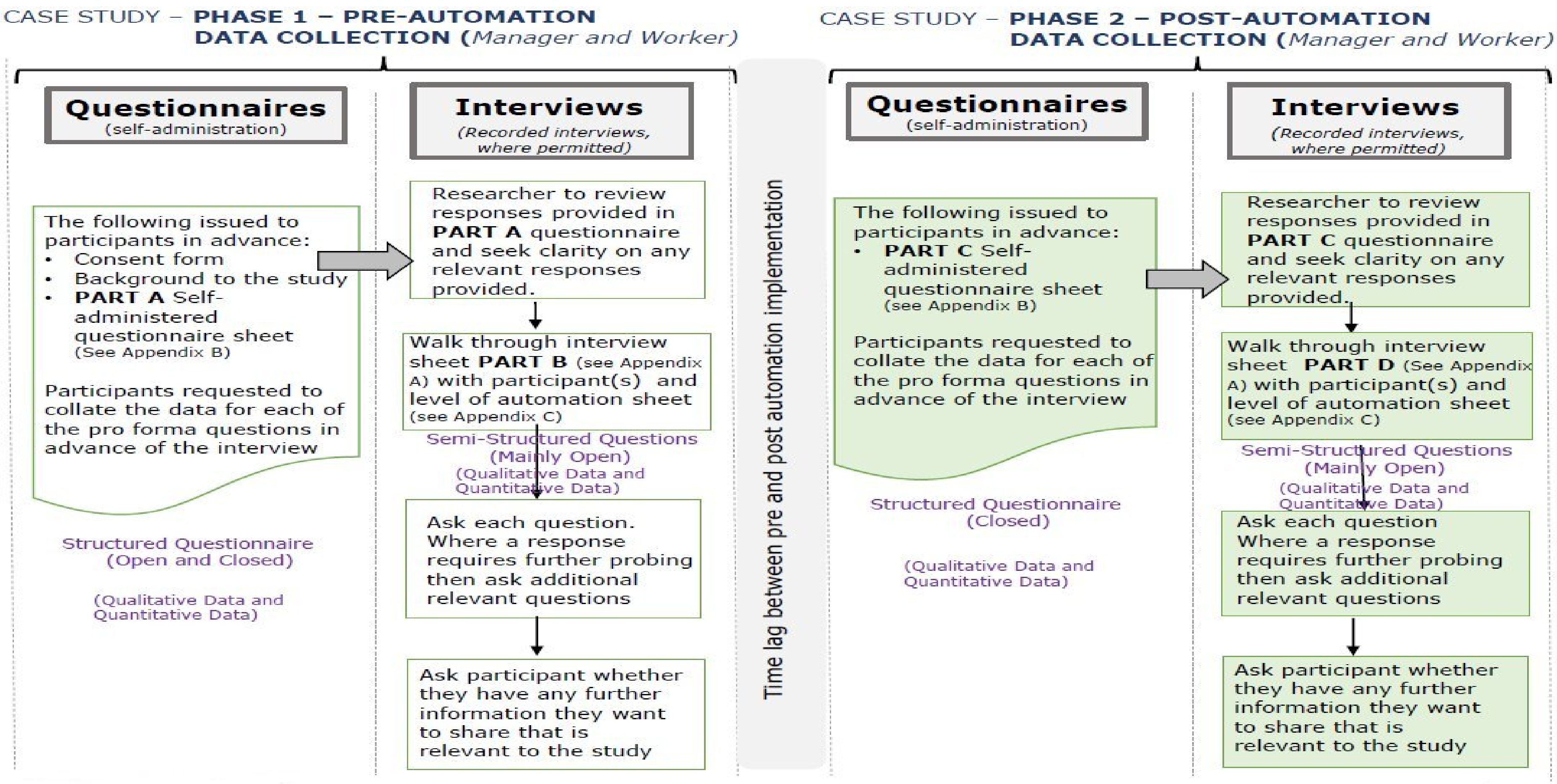
The structure of the post-automation questions aligned to the second research question exploring job characteristics, skills characteristics and work context. It was also targeted at managers and workers. The aim was to understand the impact and consequences on the workers and the tasks after the deployment of the BPAuS technology. Participants were given the same diagram and description sheet (see Appendix C, Section C2) shared during the pre-automation phase and asked to confirm the level of automation they believed automation had delivered. Probing questions were used to encourage participants to describe what the change had meant for them and to clarify and explain their answers. In the second interview set, several closed questions were also asked (using a Likert scale). The reason for this was to explore participants' views on the outcomes of automation. The structure of the automation abeyance questions was targeted at managers. The broad open questions focused on understanding the reason for moving the automation into abeyance and whether this position was likely to change or if the implementation would be cancelled. The questions also explored what the suspension meant for the tasks being performed and the future output and outcomes expected for the process.

To address the third research question, related to exploring the suitability of the UTAUT model (see Figure 2), a self-administered closed questionnaire was viewed as the most appropriate research instrument. UTAUT studies have mainly used closed questions (Muhayiddin et al. 2011; Maillet et al. 2014; Mutono and Dagada 2016). To provide confidence in the research instrument and approach taken, the research focused on assessing the four main constructs of the UTAUT model (effort expectancy, social influence, performance expectancy and facilitating conditions). The moderating effect of age, gender, experience and voluntariness to use were not considered in this study because of the small sample size. The questions previously used to validate the UTAUT model against a technology (Venkatesh et al, 2003; Aggelidis and Chatzoglou, 2009; Melas et al. 2011; Yu 2012) were carefully reworded to fit the BPAuS technology context relevant to this study (see Appendix G). The study assumes that the existing questions used to assess the constructs of the UTAUT model are relevant when applied to BPAuS technology. The questions used a Likert scale with five levels of possible answers from strongly disagree to strongly agree. The questionnaire was administered to the same set of interviewees involved in the first two research questions rather than all workers in the department, because of time and work constraints faced by workers. An extended UTAUT2 model (Venkatesh et al. 2012) existed that incorporated three additional optional constructs (hedonic motivation, price value and habit). The revised model was not relevant for this study for two main reasons. First the new constructs specifically related to people's intentions to use consumer technologies, for instance computer game machines and mobile phones and to assess people enjoyment of these devices. These were not factors or devices relevant to the study. Secondly, Venkatesh et al. (2012) suggested that the constructs of the existing UTAUT model remains suitable for assessing technologies in a workplace context and the existing constructs should continue to assess workplace technologies. The data collection process for the interviews and self-administrated questionnaire (stage 6 of the multiple case design, Figure 8) is illustrated in Figure 10.

The construction of each question for the questionnaire and interviews was formulated to ensure respondents could answer them easily, formulated in a language the respondents understand, avoiding abbreviations, colloquial expressions and jargon. Fighting familiarity heuristic was an important consideration. Care was taken to elicit the salient points from participants in order to obtain the data required whilst not being judgemental. The open questions were non directive allowing participants' considerable freedom to answer in their own words and in their own time. This approach ensured that the participants did not feel they were being judged by my existing knowledge of the subject and allowed for new areas of discovery. The questions were incorporated into a number of interview sheets (see Appendix A) and self-administered questionnaire (see Appendix B), each data gathering instrument addressing specific aspects of the research questions.

Interviews were conducted in person, with managers and workers mainly interviewed separately. In most cases, the interviews were one to one with a manager or worker, however, in some instances, several workers attended the same interview session during the lunch break. This was necessary when requested by managers to limit any impact on their work duties. Separate to the interviews and questionnaires, managers also shared supporting documents with the researcher. These included work instructions on the existing processes, process maps and timesheets of workers detailing time spent on the process.

Figure 10 - Case study data collection process



3.4 Research Sites and Conducting Fieldwork

3.4.1 Research Sites

The research is set within the National Health Service (NHS) where the researcher is employed. At the time of the research, only two health organisation sites in Wales had received approval and funding from their management board to progress with the deployment of BPAuS automation technology. This followed a supplier demonstrating the capabilities of their BPAuS technology to managers from five departments across ten health organisations in Wales. Managers from a shared service organisation and a local health board put forward separate business cases to explore the use of the technology. In total, six business processes across five departments were presented in the business cases. The researcher contacted each of the departments to explore their participation in the study.

The first research site was an NHS organisation (organisation A) that employs 2,000 staff, has a budget of £400m and provides a range of operational and support services to its customers (all the health organisations across Wales). The company provides a broad range of business services that include: Procurement Services (550 staff), Employment Services (315 staff), Primary Care (277 staff), Audit and Assurance (52 staff) and Central Team eBusiness Services (16 staff). The researcher is an employee of company A. The company was keen to embrace modern ways of working to assist with driving forward greater operational efficiencies, manage workload and the use of its finite resources. The Procurement Services and Employment Services business areas were chosen because they were in the process of exploring the use of automation and had funding in place to develop relevant solutions. The managers in these two business areas identified five business processes for initial automation consideration. These processes were across four departments, Procurement, Accounts Payable, Recruitment and Payroll. Each of these five processes form the basis of a separate case study for the research.

The second research site was an NHS organisation (organisation B) that employs 14,500 staff, has a budget of £1.1 billion and operates across eight clinical boards. The Temporary Staffing Department was chosen for this study because they were looking for a technology solution to address an immediate business challenge faced with one of its processes.

The number of case study sites was restricted to those locations where BPAuS technology was being considered. Two NHS sites and all six business processes were chosen as case study sites (see Table 4) because they provided an opportunity to compare and contrast the data collection from the different distinct deployments of the technology. The number of processes ensured there was depth and robustness to the study. One of the locations was used as a pilot site to test the research instruments.

Table 4 – Case study sites

Case Study Reference (CS)	Name of department and business process
Statement	Department: Accounts Payable Process: Supplier Statement Reconciliations
Catalogue	Department: Procurement Services Process: Supplier Catalogue Extension
Appointment	Department: Employment Services Recruitment Process: New Appointment Form
Roster	Department: Temporary Staffing Department Process: Shift Pattern Payment
Contract	Department: Employment Services Recruitment Process: New Staff Contract
Payroll	Department: Employment Services Payroll Process: Hire Applicant Process

3.4.2 Pilot Site

The interview questions and questionnaires were piloted to ensure a suitable structure and flow of the questions, the interview process and management of the self-administered questionnaire instruments (Kitchenham and Pfleeger 2002; Wilkinson and Birmingham 2003). It was important to ensure the participants clearly understood all the questions and that the outcome allowed for a richness in the data collection to address the research questions (Barley l and While 1994). The pilot also allowed the researcher to have a better understanding of the time commitment required so that expectations could be set with participants.

The statement reconciliation activity at the Statement site (see Table 4) was the first process proposed for automation and therefore this process became the pilot site. The pilot was undertaken for the pre-automation and the post-automation phase of the deployment. The participants were two managers and two operational workers from the statement reconciliation team (see Section 3.4.3 for participant selection). The testing of the pre-automation phase questions identified several questions that needed to be re-worded because the participants did not understand the question or required additional clarity. For instance, a manager and a worker asked what was meant by the question "*Do you know if the business process and tasks are efficient and optimised*". The researcher presented modified questions to participants until it was correctly and consistently interpreted. The revised question agreed with the participant was then changed in the updated questionnaire sheet. In another case, each participant was given a sheet describing eight different levels of automation (see Appendix C, Section C1) that could be deployed for a business process. These ranged from one representing no automation to level eight representing full intelligent automation control with no human intervention. When asked to select the level of automation expected from the automation of their process, the managers and workers struggled to relate to automation levels three to six for their own business processes. This was because they felt the descriptions for these levels were too similar. The sheet presenting the level of automation was simplified to make it easier for the participant to select a suitable level, with the number of categories reduced from eight to five (see Appendix C, Section C2). This was supported by a diagram to illustrate each level of automation (see Figure 9).

The questionnaire and interview stages as described above were repeated several months after the automation was implemented as part of the post-automation phase of the exercise. Throughout the pilot study, changes were made to several questions that were not understood by participants to strengthen clarity and completeness. The participants were asked again, using the modified questions to ensure the questions were correctly and consistently interpreted by workers and managers and avoided ambiguity and confusion. The outcome from the pilot exercise was an updated set of questionnaires and interview schedules for both phases (pre and post-automation) of the study. The pilot process confirmed the suitability of the administration process for the cases study interviews and questionnaires and that the questions asked, addressed the research questions. The pilot was included as one of the case study sites because of the rigour of the process followed and the richness of the data collected from this exercise that was relevant to the research.

3.4.3 Participant Selection

The participants were selected using convenience sampling (Etikan et al. 2016). This reflected the nature of the new technology and the availability of the participants at the time of the study, their ease of accessibility and their willingness to participate. Although there are recognised biases inherent in a convenience sample (Hedt and Pagano 2011), to provide suitable adjustment for the bias, the research includes the contribution from diverse participants in each case study, in particular workers and the manager. The workers were included because they are the people who, as part of their job roles, are responsible for manually performing the process and tasks and therefore would be impacted by the deployment of the new technology.

One of a number of managers at each site was selected. The managers were chosen based on their involvement in managing the processes and in overseeing the team of workers that would be impacted by the new technology. The manager was responsible for confirming how many workers could be freed to support the study. It was anticipated that there would be one manager and up to three workers participating in each phase of the case study. The number of managers and workers changed from what was anticipated due to work pressures. The number of workers affected was small. Sometimes it was not until the day of the interview that the researcher was notified of the number of participants available to be interviewed. It was expected the same participants would be interviewed for the pre-automation and post-automation phases of the study. For several case studies, this was not possible due to the commitments of the workers and other immediate priorities. The actual number of participants in the study pre and post-automation are set out in Table 5.

Table 5 – Actual Sample Size (Pre-Automation and Post-Automation)

Case Study Reference	**Pre-Automation**			**Post-Automation / Automation in Abeyance**		
	Managers	**Workers**	**Total**	**Managers**	**Workers**	**Total**
Case Study 1: Statement	2	2	**4**	2	2	**4**
Case Study 2: Catalogue	2	3	**5**	1	3	**4**
Case Study 3: Appointment	2	3	**5**	2	1	**3**
Case Study 4: Roster	1	1	**2**	1	1	**2**
Case Study 5: Contract **	2	2	**4**	1	1	**2**
Case Study 6: Payroll **	2	1	**3**	1	1	**2**
Total Sample:			**23**			**17**

Note: ** - case studies where the automation moved into abeyance

The sample needed to be of sufficient size to allow richness in the data collection for the identification of patterns in the data using thematic analysis. A sample of sufficient size could also enable exploration of commonality across case studies and reducing researcher subjectivity. Mason's (2010) review of 1400 qualitative case studies identified that the sample sizes varied between 1 and 95, with a mean of 35. Braun and Clarke (2006) argued that in reflective thematic analysis studies, an acceptable total sample size for medium size projects should be between 10 and 15, however, the sample size is subjective and depends on the context, the determinants that define project complexity and size and the researchers own perception on what is reasonable (Braun and Clarke 2021). For the purposes of this study, the total sample size for the pre-automation multi-case phase and post-automation multi-case phase (see Figure 10) was assessed to be reasonable to provide robustness to the findings by allowing varied evidence to be considered across a number of different locations and to enable comparisons across case studies. The total participants for all case sites was within the range suggested by Braun and Clarke (2012) and Mason (2010).

All participants were briefed individually about the project, provided with the opportunity to ask questions about the study and then handed the consent form (see Appendix D). The consent form was to confirm their participation was voluntarily, they were free to withdraw from the study at any time and that the data they provided would remain confidential and used only for the purposes of the study.

3.4.4 Data Collection

There are two phases to the data collection for each case study (see Figure 10). Phase 1 involved engaging with participants before the deployment of BPAuS. During phase 1, a self-administered questionnaire was issued to participants (see Appendix B) at least two weeks before the planned interview. The questionnaire required participants to provide details on the processes being considered for automation, the issues and challenges arising (separate ones for manager and workers). Participants were requested to return the questionnaire by email at least one working day before the scheduled interview. During the semi-structured interview, the questionnaire responses provided by participants were reviewed to clarify any points in the information provided. This was then followed with more detailed probing questions on the processes, the job roles and characteristics involved and resource efforts (see Appendix A). During the interviews, the participants' understanding of the expectation of the outcome and output from the proposed automation was sought. The process included sharing a diagram depicting five levels of automation (LoA) (see Appendix C, Section C2) and seeking the participants' view on the LoA they perceived was expected to be delivered.

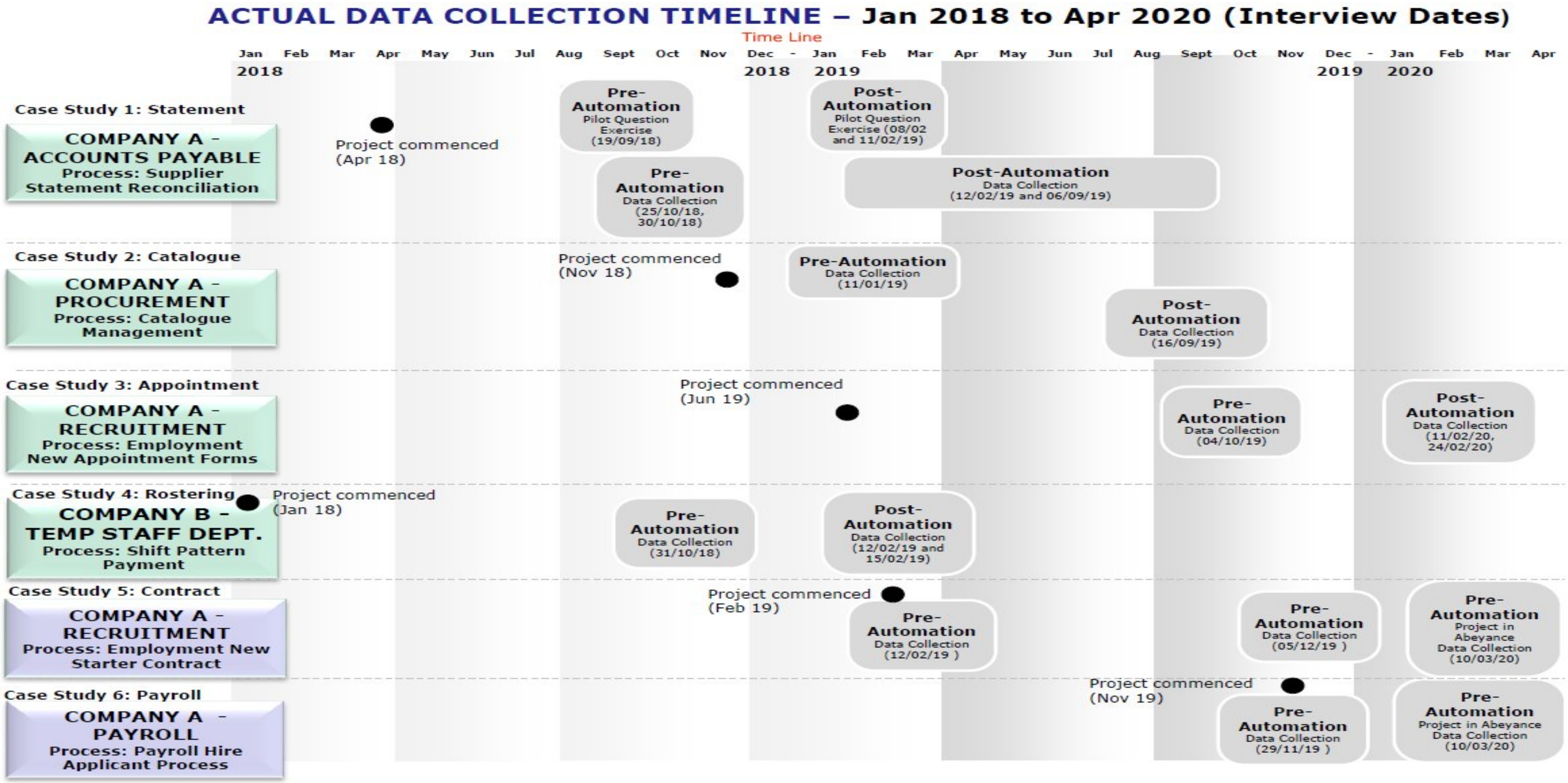
During phase 2, a self-administered questionnaire was issued to participants (separate ones for manager and workers) at least two weeks before the planned interview date, with participants requested to return the completed questionnaire by email at least one working day before the interview. The aim of this questionnaire was to address the third research question and assess the suitability of the UTAUT model. A semi-structured interview was conducted with participants during this phase to understand what the implementation of BPAuS technology meant to them, and what actual output and outcomes were being delivered. This included sharing five levels of automation (LoA) diagram (see Appendix C, Section C2) and requesting the participants' to confirm the LoA they believe has been delivered.

The actual data gathering timelines are detailed in Figure 11. There were slippages at all the sites; the reasons for this are detailed in chapter five (post-automation findings). The date and time of the interviews were chosen by a manager at each site to fit around their availability and work schedule. The interviews were held face-to-face at the participant premises to maximise their availability in their natural setting. In the few instances where the researcher could not attend the participant place of work, due to commitments of the researcher or weather, then these interviews were conducted by telephone.

Participants were asked to confirm whether they would allow the interviews to be recorded using a voice recording device. The purpose of the recording was to facilitate a better interaction between the researcher and the participant to understand nuances and their responses. The approach reduced the time needed for the interview sessions because the researcher did not have to slow the discussion down to facilitate simultaneous note-making. The approach also reduced errors in the researcher's record of verbatim responses. All recordings were transcribed by the researcher into a Microsoft Word document against the questions. The transcriptions were shared with the participant for them to confirm they were an accurate reflection of what was said during the interviews.

During each interview, field notes were kept as an aid-memoire of any additional probing questions asked to participants and their responses that were not on the initial list of interview questions. Following the interview, the additional questions were added to the interview schedule to ensure completeness whilst allowing for any specific nuances between participants' responses to be captured.

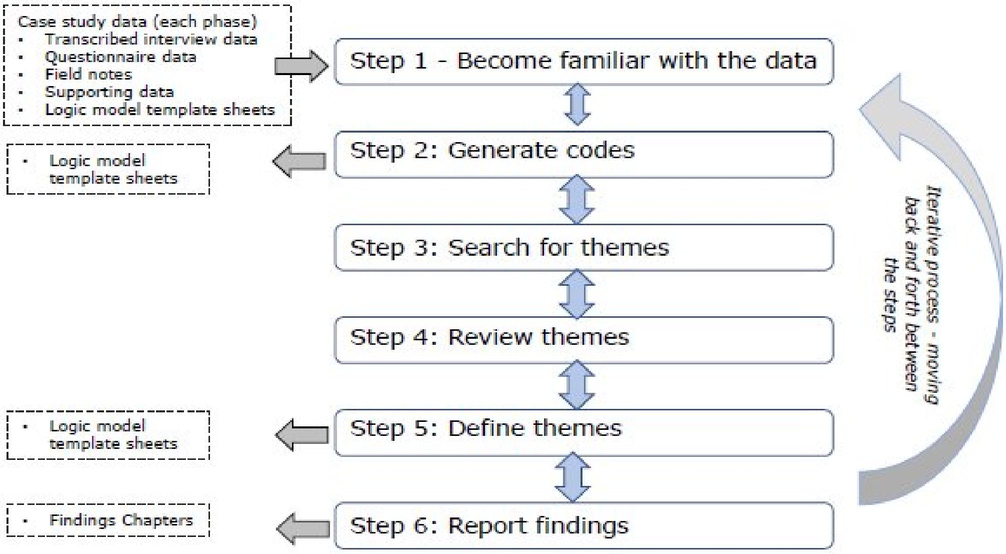
Figure 11 – Data gathering timelines (actual)



3.5 Data Analysis

Thematic analysis was chosen to capture and analyse relevant data from participants relating to their behaviour, actions and thoughts (Creswell 2009). Thematic analysis is a widely used approach for analysing qualitative data to identify patterns of meaning (themes) in datasets that emerge as being importance to the description of a phenomenon (Braun and Clarke 2006; Ibrahim 2012; Vaismoradi et al. 2016). Thematic analysis can be used where a study seeks to understand the influences of participants at different phases of data collection, for instance at the beginning and end of a project (Creswell 2009). A number of studies, for instance Javadi and Zarea (2016), highlight several criticisms of thematic analysis in particular the large number of interpretations that can be placed on the data that then potentially gives rise to bias and questionable reliability in the codes and themes generated. A further concern is finding and verifying relevant codes and themes. To ensure rigour in the research and lessen bias and limiting the extent of any interpretation required, the codes and themes that emerge are those transcribed from the participants' views and accounts of events. A number of thematic analysis tools exist to assist in the recognising of an important moment and coding the data prior to the process of interpretation to develop themes. These include reflective, coding reliability and codebook (Miles and Huberman 1994; Boyatzis 1998; Braun and Clarke 2006; Vaismoradi et al. 2016). Although all of these tools have merits, each differs in their approach to analysing, collecting and coding the data to generate themes. Braun and Clarke (2006) argue that thematic analysis provides flexibility and rigor using deductive and inductive approaches to analysing qualitative data (Frith and Gleeson 2004). The combined technique of inductive and deductive methods lends itself to this study by allowing the tenets of a phenomena to be explored through the process of deductive analysis using the reflective thematic analysis framework presented by Braun and Clarke (2006). The framework defines a structure to organise data from questionnaire responses for subsequent interpretation, to identify an important moment in the data and allow themes to emerge using inductive coding outlined by Boyatzis (1998). The approach provides links between themes and the research question to guide the development of analytical claims (Burnard et al. 2008; Ibrahim 2012). Braun and Clarke's (2006) framework was chosen because it is widely used across many thematic analysis studies, including in healthcare settings and aligns with the activities to be performed for this study. For this study, the coding and theme development process involved the six steps of the reflective thematic analysis framework (see Figure 12). The process was performed separately for each phase of the case study (pre-automation and post-automation).

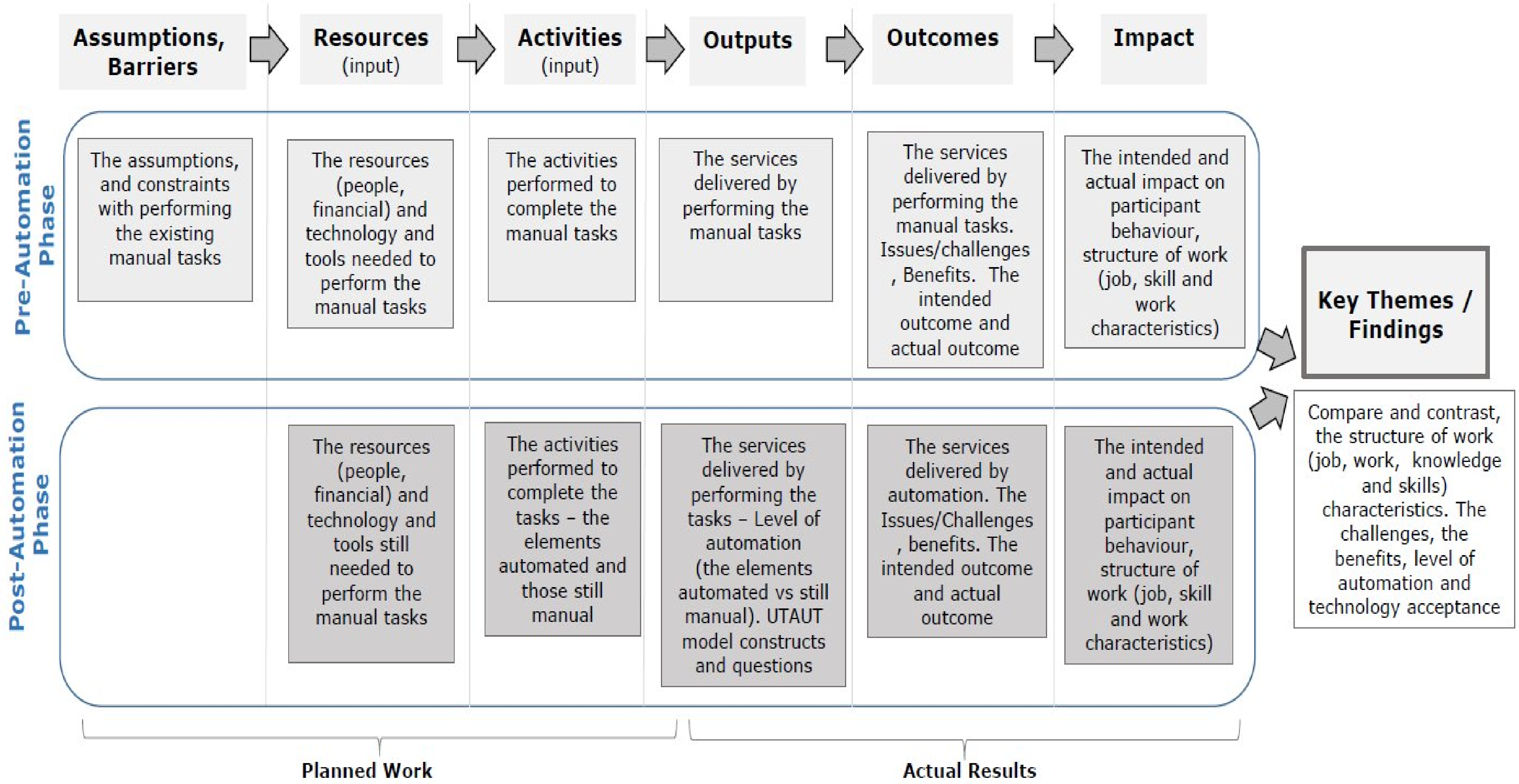
Figure 12 – Thematic analysis steps to code the data
(Adapted from Braun and Clarke 2006)



Step (1) required familiarisation with the data (Rice and Ezzy 1999) by immersing in the data collected through reading and re-reading the interview transcripts, open questionnaire responses, field notes and the supporting documents provided by participants. To structure and "unpack" (Walters 2016, p. 107) the large body of text captured from the interviews, questionnaires and internal documents in each case study, the logic model framework (Knowlton and Phillips 2013) using the output design approach was used (see next paragraph). Step (2) required the reading of the transcripts and the systematic analysis of the data to identify any important feature observed in the data that was relevant to the research questions. Each identified feature was manually coded to generate the initial codes (i.e. words and phrases) and recorded against the appropriate headings in the logic model template document sheet (see Appendix E). Burnard et al. (2008) argues that adopting manual analysis is as rigorous as using software (such as NVivo) and ensures the researcher is immersed in the data. Step (3) involved the search for initial themes by identifying patterns in the codes. This was achieved by combining multiple related codes and categorising them to identify relationships and patterns (Boyatzis 1998). A theme was characterised as any attribute, descriptor or concept (Ayres et al. 2003) that organises a group of recurring patterns in the subject of inquiry that was of importance, prior to the process of interpretation to seek discovery (Miles and Huberman 1994; Ryan and Bernard 2003; Bradley et al. 2007). Step (4) required the potential themes to be reviewed, identifying categories and labelling them. This was a recursive process to ensure the codes and themes remained relevant to addressing the research questions. Step (5) involved reviewing the captured themes, assessing each one for their relevance in relation to the research questions and defining the named themes by describing them. Step (6), the final step in the process, involved presenting the findings from the analysis. The process was iterative, moving up and down each step, many times to identify codes and themes as a means to gain insight.

Knowlton and Phillips' (2013) logic model framework provided structure to capture the data analysis, allowing for a comparison of what had changed between the pre and post-automation phases of the study at each site. Thematic analysis was used to identify the codes and emerging themes, with the quantitative data captured, for instance level of automation and time spent performing a task recorded against the appropriate headings in the framework. The framework allowed for the careful consideration of the relationships (or connections) between activities and resources associated with the outputs, outcome and impact to people, processes, job and skills characteristics and workers' role pre-automation and the same activities and resources post-automation (see Figure 13). The inputs for the logic model are the resources, technology and tools needed to perform the process/task. The activities are the processes and tasks being perform, whether performed manually or using automated technology. The outputs are the direct results of the program activities and detail whether the activities delivered what was intended. The outcome captures the changes arising to the people, processes, job and skill characteristics and workers' roles. The impact captures the consequences and challenges for the people, processes, job and skills characteristics arising as a consequence of the actual results. The structure of the logic model uses words and visualisation to explore any relationship between context, input, output, outcomes and impact to arrive at an analysis of the factors that result in the intended and unintended effects, together with the wider generalisation and triangulation of evidence (Cruzes et al. 2014).

Figure 13 – Logic model based on the outcome approach framework (Adapted from Knowlton and Phillips 2013)



To assist with the thematic analysis process for each case study, the verbatim responses from the interview transcripts were mapped against each of the interview questions. This provided some structure to the responses against each of the questions asked. Thematic analysis was used in each phase (pre-automation and post-automation) of the case study to extract key information on the views, experiences, challenges captured in the transcribed interviews, questionnaire responses and field notes.

To facilitate the comparison of commonalities and differences relating to the UTAUT model across all the case studies, the responses from the post-automation questionnaire were mapped to the UTAUT model comparison template sheet (see Appendix G). The statistical analysis method used to analyse the five point Likert data was mode (most frequent response). The supporting text provided against each response was analysed using thematic analysis. This allowed for any clustered patterns of commonalities and differences in the responses to be analysed against the questions asked in relation to each UTAUT model categories.

3.6 Research Ethics

Research in a health and social care environment requires ethical approval from the research ethics committee at the health organisations partaking in the study. Ethical approval from Cardiff University School of Social Science ethic committee was obtained. Following this, approval to conduct the research was also received from organisation A and from organisation B through the IRAS process (IRAS ID-224046). Only when all relevant ethical approval was received could the data collection exercise commence (approval references: 2017/VCC/0047 and SREC/2204).

The research complied with research governance protocols and ensured compliance with all relevant ethical considerations. These include: a) informed consent - to ensure all participants fully understand the purpose of the study and are free to participate in the study; b) right to withdraw - all participants are given the opportunity to withdraw from their participation at any point in the study. Any data collected prior to the point of withdrawal would be used; c); anonymity – to ensure all data provided by participants remain confidential and all participants remain anonymous.

Participants did not raise any concerns with their verbal or written contribution to the research study, the data collection process and for their department details being referenced in the case study. To preserve the anonymity of each participant, anonymous unique identifiers were assigned. The approach was suitable for the study because each site comprised of a number of managers and workers, with the smallest department having six managers and ten workers, therefore making it difficult to identify an individual. This allowed the participant to freely express their views, concerns, challenges and experiences related to the study, knowing that anonymity was ensured and that the data provided would not be used against them. Whilst pseudonyms could be argued to be an issue for instance, that prevents research participants attaching their name to a message (Crow and Wiles 2008) it is also argued that it does not make it louder (Vainio 2012). Each participant was assigned a unique identifier which referred to the participant's broad job role (for instance manager or worker) in each case study. For example, participant "Statement.Worker1" refers to the relevant case study (Statement), and the relevant worker (Worker1) in that case study. A secure protected workbook was maintained to map each participant name and contact details against the associated unique identifier. The secure workbook was used for administrative purposes to enable the scheduling of interviews and returning of questionnaires.

3.7 Representation and Reflexivity

Qualitative research typically requires the researcher to have direct engagement with participants, the research environment and subject matter. The researcher is an employee of the NHS in Wales and works in the field of digital technology. As a consequence, careful consideration was required on my role and responsibilities in the study. According to Bonner and Tolhurst (2002), being an insider researcher has some advantages, such as having a greater understanding of the environment being studied and having intimacy to promote the telling and judging of truth. My knowledge in this field benefits the research through having an understanding of the culture within the healthcare sector. As an employee of the NHS I have access to managers in a significant number of departments that may be exploring automation technology to identify opportunities to participate in the research. My understanding of digital technologies and business processes allows participants to be probed further during interviews.

Critical reflection led me to understand, examine and consider my position within the research. The purpose of this critical reflection was to reduce any impact on actual behavioural events and outcomes by my prejudiced views and assumptions. This was necessary from several perspectives: 1) my existing knowledge and experience of BPAuS technologies and familiarity with the subject matter, whilst acknowledging that my opinions are subjective; and 2) my professional working relationship with the organisation under study and with some of the participants that took part in the research.

There are a number of strategies to fighting familiarity and the insider role that were applied to my study, to challenge any personal preconceived notions and perceptions. There is no single reflective approach that may necessarily be successful, however, one of the approaches is the use of visual methods, for instance illustrated drawing (Mannay 2014) to enable participates to reflect and present their own thoughts, meanings and views and concepts. A second strategy is to use open-ended questions and provide participants with non-directive freedom to answer in their own words and time (Wiederhold 2015). The study used visual methods and open questions to fight familiarity and to challenge any personal preconceived notations.

Being an insider researcher (Unluer 2012), it was necessary to ensure that prior to commencing the interviews and in the covering information sheet when administering the questionnaire, participants were reminded that my role was solely as a researcher conducting this study and in no other capacity. I made it clear that I was not judging participant responses and seeking to only document their views. As well as reminding participants of this, I also ensured the focus of all discussions remained on the research subject and nothing else. During interview sessions, I dressed smart casual to help create a less formal persona. Having existing knowledge in the technology under study, I frequently examined and reflected on my position within the research and was careful not to lead on any additional questions asked during the interviews. I believe the approach taken did not prejudice the event our outcomes. In addition, any observations made were not shared with any of the other participants. Instead, any thoughts, feelings, impressions were noted and shared only with my supervisors. This approach was taken to not influence the data provided by the participants, enhancing the credibility of the data collected.

3.8 Research Constraints

There were some constraints associated with conducting the research. Firstly, the data collection required workers and managers to participate in the study during office hours. It was necessary for participants to commit sufficient time to complete self-administered questionnaires and return these to the researcher. The participants also needed to spare time to attend several interviews. It is recognised that due to the workload and time pressures in some departments, not all participants were available to partake in the study. It was therefore important to strike a balance between ensuring sufficient questions were asked in the questionnaire and during the semi-structured interviews and the time commitment available from participants. To minimise any impact on participants potentially withdrawing from the study, the interviews were conducted at the participants' premises, and performed on a date and time suitable to them. This required me to be flexible in terms of dates, times and the locations visited for the interviews.

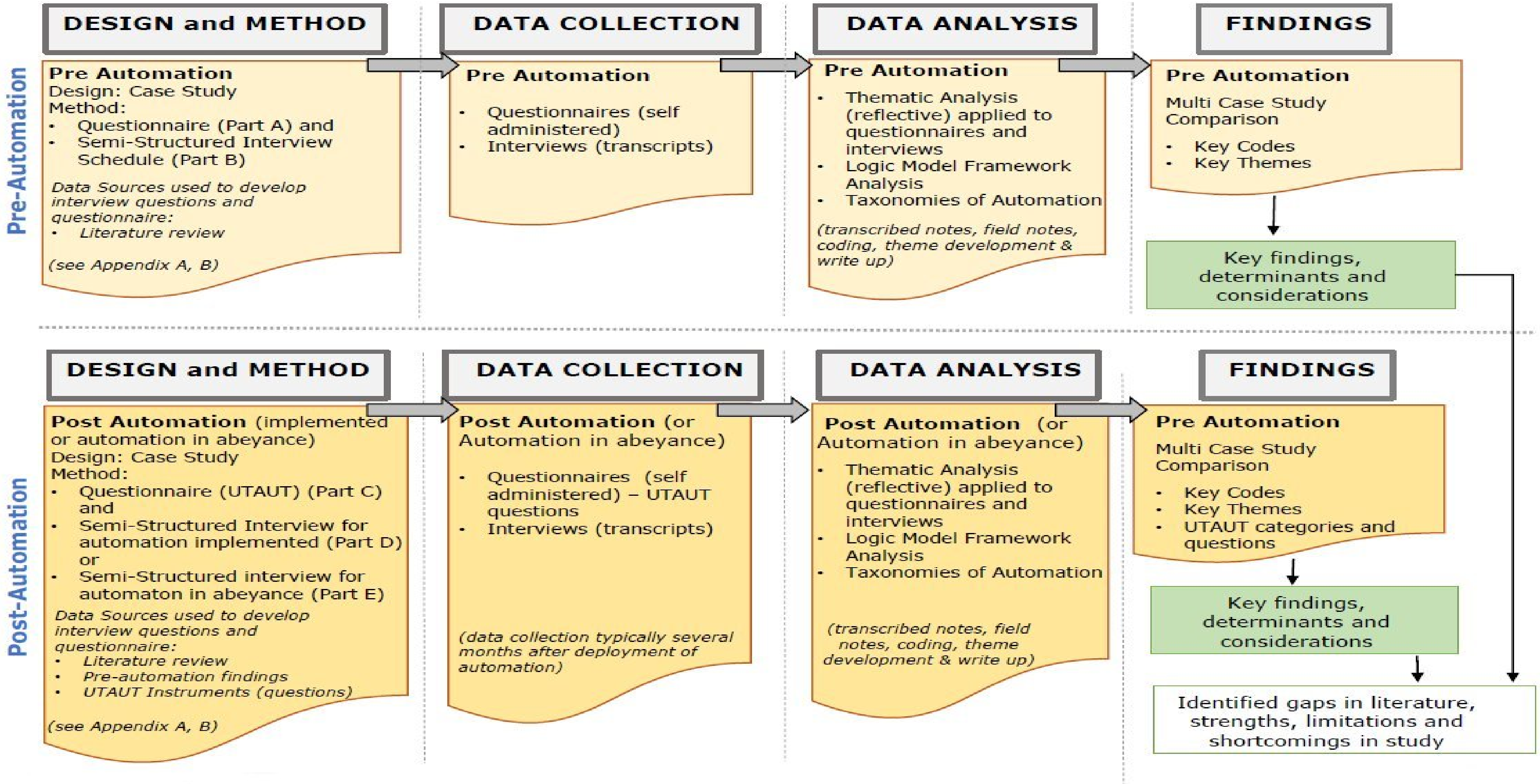
Secondly, the post-automation phase of each case study was dependent on the timelines for when the BPAuS technology was implemented. The timelines were outside the control of the researcher, and did result in timelines slipping or in some instances the automation moving into abeyance. In these situations, it was necessary to be flexible and re-schedule the interview dates and review the sequence of collecting data for the remaining case studies. Although this impacted on the quantity of data collected post-automation, it did not impact on data analysis and the quality of the data collected and allowed exploration of reasons for abeyance.

3.9 Conclusion

The case study design reflects the nature of the research questions whilst ensuring the aims and objectives of the research are met (see Section 2.5). This drives the context of the case studies, the interview questions, the questionnaire design, the nature of the data collected for the research study and the use of an outcomes approach logic model to structure the responses. To provide robustness and depth to the study, six case studies across two NHS sites exploring BPAuS technology were used. An overview of the research methodology for this study pre and post-automation is set out in Figure 14.

Throughout the study, my position in the study was constantly considered and reflected on to reduce bias and to minimise my influence on the data collected.

Figure 14 – Overview of research methodology



Chapter Four: Case Study Findings I – Pre-Automation

The aim of the research is to understand the determinants influencing the use of BPAuS technology in a workplace setting and whether this impacts on job, work and skill characteristics. An additional aspect is to understand whether the UTAUT model captures the key elements to assess workers' intention to use BPAuS technology. The deployment of the technology is examined across six case study sites: case studies one to four implemented BPAuS but in case studies five and six the automation was not implemented. The findings are presented across three chapters.

This chapter examines the manual tasks and processes performed at the six sites, the reason for considering automation, and any existing challenges with the present tasks. The chapter explores the workers performing the tasks, their job roles, skills and managers and workers expectation on the level of automation to be delivered.

The source of the data analysed are from the interview transcripts, questionnaire responses and supporting information (for instance documentation detailing the time spent completing tasks). Chapter 5 presents the findings after the deployment of the BPAuS technology and chapter 6 details the findings on whether the UTAUT model contains the key elements to explain workers' intentions to use the technology.

4.1 Case Study 1: Statement (Supplier Statement Reconciliation)

4.1.1 The Department: Statement

The Accounts Payable department at organisation A comprises a large number of teams, one of these is the Statement Team. The two managers interviewed explained that supplier reconciliation is an important activity for the department, to meet internal policy obligations and to work with suppliers to confirm the financial position on payments. Statement.Manager1 reported the activity needs to meet the department performance targets, "*to help improve customer-supplier relationship*", to ensure "*invoices are promptly paid*" in accordance with the Public Sector Payment Policy and to ensure "*there are no issues with the invoices still to be paid*". They explained that activity should ideally be undertaken every month and within three days of receiving the statement file from the supplier. According to Statement.Manager1, the workers' job roles reflect the need to manage three core activities that entail (in the order of importance): preparing supplier payment files for BACS, managing telephone help desk calls and undertaking the supplier statement reconciliation exercise. A third of the workers' time should ideally be spent on each core duty. Statement.Worker1 reported that at present the reconciliation task is only undertaken when there is time for them to complete the activity alongside their other core activities.

The reconciliation activity entails staff emailing suppliers requesting they send their statement report of all invoices they believe have and have not been paid in the preceding month by any NHS organisation in Wales. The information is requested on the last working day of the month or the first working day of the next month, with the request expected to be completed in a pre-defined Microsoft Excel template format. The NHS in Wales deals with over 20,000 suppliers every year, however, the Statement Team only requests information from the top 50 suppliers based on the highest volume of invoices sent to the NHS every year. Once the supplier has sent in their reconciliation report, the Statement Team runs a report from the Finance system to create an NHS Microsoft Excel file. The information from the supplier statement file and the NHS file are then reconciled known as the matching process. The aim of the matching process is to ensure all invoices (from the 50 suppliers) are accounted for by the NHS and that the status of any overdue or unpaid invoices are understood and explained to the supplier. The managers mentioned that the matching process is estimated to take 73% of a one worker's time. This equates to 1,320 hours per annum, based on processing about 165,000 statement lines per annum from the 50 suppliers across all health organisations.

The workers in the small Statement Team are on grade 3 earn between £17k and £20k per annum. Clerical workers in the NHS are on salary grades between 1 and 4. No specific qualifications are required to perform the job, however all current workers have one or more general certificate in secondary education (GCSE) qualifications and in some cases advance level (or equivalent) qualifications. The staff require good telephone manners, are expected to have skills to know how to use a computer and to be able to concentrate for long period of time. They are trained to use Microsoft outlook email, and how to run reports from the Finance systems and use some basic functions in Microsoft Excel, for instance Pivot-table.

In 2015, all Accounts Payable managers attended a demonstration from a company selling process automation technology. This gave managers some insight into the potential benefits that automation could bring and what could be achieved. Statement.Manager1 put forward the supplier statement reconciliation activity for automation because it was considered to be a routine and straightforward task and automating this activity would free workers time to focus on other duties.

4.1.2 Constraints and Challenges: Statement

All interviewees identified a number of challenges with the present process. The managers stated that the activities were reactive in nature. This was supported by Statement.Worker1 who commented:

> "*the statement reconciliation happened when a supplier phones to query their payment rather than being more pro-active by us*".

It was important for the reconciliation to be accurate and correct. If there were errors in the reconciliation this could create complaints and issues from the supplier. Due to delays in completing the activity there were missed opportunities to reduce costs for the NHS, with Statement.Manager1 saying these include:

> "*tak[ing] advantage of increased early payment discount opportunities and to release staff time to focus on more value added support activities*".

Statement.Worker1 reported that progressing these opportunities and being more proactive at managing the task was made difficult because of the large number of phone calls received from suppliers querying payment.

To manage the number of telephone calls received, the Statement Team had to limit the number of queries answered from each supplier to five minutes per call. This restriction was deemed necessary to ensure the staff balanced their workload across all their core activities. Suppliers found this frustrating given they were trying to clarify payments. A further challenge reported by the two workers was the time taken to reconcile each supplier statement against the position on the NHS Financial system

> “[the] *matching process is time consuming, takes about 40 minutes per statement to complete and requires intense concentration during this period to analyse and reconcile each statement line*”. (Statement.worker1)

Phone calls received when the workers were concentrating on the reconciliation process were not answered to avoid distraction and mistakes happening. Because of the time taken on the matching process, the activity was only completed for the top 50 suppliers each month. Statement.Manager1 reported the activity should ideally be performed for all 20,000 suppliers to ensure the financial position and balances are accurate for all purchases. This was not practical with the present number of workers in the Statement Team.

All interviewees identified a number of issues with the information provided by suppliers that meant time was being spent to correct the data before the reconciliation process could work. The most important issues related to the different data format files received, such as PDF documents, different Excel formats and emails, despite asking all suppliers to complete a pre-defined Microsoft Excel document template. Statement.Worker1 stated that suppliers “*sent us what they believed we wanted*” rather than what was requested. This required the Statement Team to sort the data and collate this into a consistent format.

Due to resource pressures and other work priorities, it was felt nothing could be done to change the present situation and address the present challenges. Statement.Manager1 remarked:

> “*there was a missed opportunity to reduce [the number of] supplier [telephone] query resolution* ”.

There was also missed opportunities to recover costs from suppliers, with Statement.Worker1 saying: “*payment credits due to the NHS are not being recovered*”.

4.1.3 Expectations of Automation: Statement

All interviewees expected the output from automation to be an improvement on the present manual process, with the automation doing the reconcile process and providing more timely information to suppliers. Statement.Manager1 anticipated automation would ensure they met their performance targets, as well as reduce the number of supplier phone calls and workers' effort to complete the reconcile process. Further benefits would include: "*streamlining the process*", "*helping the existing role*" and was clear that it was "*[not about] replacing any of the existing staff*". Statement.Manager2 believed it would also help free the workers, saying: "*assist in paying invoices more quickly and so increase early payment discounts*".

The two workers also expected the quality of service delivered to suppliers to improve, with "*less pressure on staff*" to reconcile the statements by saving over half of the present three hours per day being spent performing the task. Both reported that it would be helpful if BPAuS could deal with supplier data issues, in particular "*format issues, missing data, data sent in different formats*" (Statement.Worker2).

Statement.Manager1 recognised that only some tasks may be automated and not the entire process because of their understanding of the technology following the training. Both managers expected the level of automation to be at level three (up to 75% performed by automation).

> "*we will still have elements [of work for staff to do] at the start of the process and end of the process*". (Statement.Manager1)

The present issues with the data would still require staff input, for instance to align the different statement file formats received from suppliers and to correct any missing data. Both workers also believed the level of automation would be at level three (up to 75% performed by automation) because they thought BPAuS would not be able to correctly interpret all the data, for instance "*distinguishing between the letter 'I' and the number '1'*" (Statement.Worker1). However, they were expecting BPAuS to know when it needed to do its task rather than this being controlled by the worker.

Success of the automation was described in terms of BPAuS performing the reconciliation process:

> "*confirming it had reconciled the statement report with no issues.*". (Statement.Manager1)

4.2 Case Study 2: Catalogue (Supplier Catalogue Extension)

4.2.1 The Department: Catalogue

The Procurement department at organisation A comprises a large number of teams, one of these is the small Catalogue Team which is responsible for managing all supplier catalogue tasks. A catalogue contains a list of goods and services that the NHS can purchase from the supplier. The tasks performed by the team include: loading new supplier catalogue items into the Procurement system, managing catalogue change requests, amending catalogue entries and extending the supplier catalogue agreement dates. The catalogue allows authorised users from any of the health organisations in Wales to search the Procurement system to find items to be purchased from one or more suppliers. A user can then select the required catalogue items, add them to their shopping basket and then checkout and purchase the items.

The catalogue extension task extends the agreement expiry date of existing items held in the Procurement system. Once an item agreement date expires, a user cannot search for that item from the catalogue. The task entails the Procurement department running a report in the Procurement system detailing the specific catalogue items that are due to expire and are to have their agreement date extended. The report is exported into Microsoft Excel format for manipulating. The Excel file details the suppliers, the catalogue items, the existing expiry date for lines and headers and the health organisations using the catalogue items. The Procurement department sends the Excel file to the Catalogue Team to set the new expiry date for catalogue items in the Procurement system and to let the health organisations know the new expiry date for the supplier agreement. The agreement expiry dates can be extended by one or more days, sometime by months or years.

The supervisor allocates catalogue files to the workers, with each worker responsible for processing the file by the due date. The worker checks all the required information is provided in the file then logs into the Procurement system, and enters the new expiry date for each catalogue item. The record is saved and the process is repeated for the next catalogue item listed until all lines in the file have been processed. In situations when the data in the file is not in the correct dd/mm/yyyy format, the worker amends it in the system. The worker ignores any additional columns found in the file that are not relevant. The number of catalogue items can vary each month, by supplier and health organisations from a single line to hundreds of lines. The amount of time taken to process a file depends on the number of lines in the file, typically taking 20 minutes to process 100 catalogue lines for one health organisation. A file containing 100 lines for each of the eleven health organisations in Wales would take about three and a half hours to process. Based on processing an average of 5,200 catalogue lines per annum, this equates to about 1,040 hours of work (0.58 FTE).

The workers in the small Catalogue Team at the time of data collection are on a salary grade 2 (salary range £17k to £18k) and salary grade 3 (salary range £17k to £21k) depending on level of experience. No qualifications are required for the post; however, the staff are expected to know how to use a computer. They are trained to use Microsoft outlook email, update catalogue items on the Procurement system and to use some basic functions in Microsoft Excel. According to Catalogue.Manager1, the workers' job roles reflect the need to manage all aspects of supplier catalogues and ensuring the Procurement system is kept up-to-date.

The managers attended a training course arranged by the IT department visiting all health organisation departments to explain the automation technology. This provided managers with insight into potential opportunities to consider the technology in their own department. Following this training, Catalogue.Manager1 put forward the supplier catalogue extension activity for automation in September 2018 because it was viewed as a simple, routine and straightforward task. The hope was that automation might ensure workers' time was used to perform other more valued activities.

4.2.2 Constraints and Challenges: Catalogue

Catalogue.Manager1 stated that the task is important and all entries must be correctly processed by no later than the last working day of the month and before the existing agreement expires. Catalogue.Manager1 asserted "*we have no choice in this*" and cannot afford to let an important agreement expire. In instances when an agreement had expired then users would phone the Procurement Help Desk to query the situation. This is more likely to happen if the item is purchased regularly or is considered critical, for instance by clinical departments.

The main challenge with the present process is to ensure the workers have not omitted to update catalogue lines listed in the file or entered an incorrect date in the Procurement system. This can happen due to human error, especially if the file contains hundreds of catalogue lines. Catalogue.Worker3 reported that when there is a large list of catalogue items to update it is a repetitive job, "*it [the updates to the date] drags on towards the end*" and this gives rise to lapse in concentration and mistakes.

4.2.3 Expectation of Automation: Catalogue

All interviewees expected the output from automation to be an improvement on the manual process, with all catalogue item agreements extended in the Procurement system before the end of the month. All interviewees expected the outcome from the automation to include greater accuracy and consistency in the updates entered in the Procurement system to allow workers to focus on their other duties.

The managers believed the level of automation to be delivered to be at level four (up to 99.9% performed by automation) because the task was straightforward. Two of the workers (Catalogue.Worker1 and Catalogue.Worker2) also believed the level of automation to be at level four, however for different reasons. Catalogue.Worker1 did not believe BPAuS would necessarily be given all the work to do and Catalogue.Worker2 expected a human to still decide when the robot would perform its tasks as they did not believe BPAuS could determine this for itself. Catalogue.Worker3 expected the level of automation to be three (up to 75% performed by automation) because they anticipated that some form of human interaction was still necessary to know what agreements needed to be extended and to confirm the new expiry date.

4.3 Case Study 3: Appointment (New Appointment Form)

4.3.1 The Department: Appointment

This case study focuses on an activity undertaken in the Appointment Team of organisation A. When candidates apply for a position advertised on the NHS job site, the application form, including employment, career and personal details are captured on the Recruitment system. When a hiring manager interviews candidates for a position, the scoring of each application, shortlisting and the final selection of the preferred candidate (appointee) is made on the Recruitment system. Confirming the candidate to appoint triggers an email notification to the Appointment Team, who then schedules the completion of the relevant appointment paperwork. The Appointment Team keeps a register of all requests received to appoint new staff and then processes each in the order received.

Processing the appointment form commences once all the pre-employment checks (for instance identity, qualifications etc) are successfully completed by the Appointment Team. The team generates a report from the Recruitment system for the appointee and imports this data into a Microsoft Excel New Appointment Form (NAF) template. The NAF also contains additional information that may not have been initially captured on the Recruitment system that needs to be collected, including bank details, national insurance number, next of kin, start date, confirmed starting salary grade, job title and office location.

The Appointment Team validate the data prepared on the NAF to ensure the details are correct and then emails the NAF to the hiring manager. The hiring manager reviews the form, completes any missing and incomplete information with the appointee present. When completed, the appointee and then the manager electronically signs the form and emails the NAF back to the Appointment Team. The Appointment Team checks the returned form to ensure all of the required information has been provided and in the correct format. The Appointment Team enters any additional and corrected information from the form into the Recruitment system. This process is repeated for each new appointee across all health organisation in Wales.

The NAF process is performed by two full-time workers on a salary grade 3 (salary range £17k to 21k) and salary grade 6 (salary range £28k to £35k). The two workers cover the activities for 14 department areas within five health organisations. There are typically 37 steps to the task to process the information for each health organisation department and 60 NAF forms are produced per day (about 10 to 15 forms per health organisation). This takes between five to six hours between the two workers to complete twice a week and about two hours of time on the remaining three days. Additional aspects of the NAF process include liaising with different departments and line managers to obtain the remaining information required for the NAF. This activity takes about an hour of the workers' time per day, which equates to about 960 hours a year, performing 240 tasks per annum. Appointment.Manager1 remarked that "*this is almost 50% of [one of] the workers' time*".

Appointment.Worker1 reported there are another three health organisations and a further 28 departments wanting the Appointment Team to handle their NAF process. With the demand rapidly growing the department needed to find a better way to manage the potentially quadrupling volume of NAFs to be processed per day.

> "*it was a no brainer for this to be roboticides or we would have to employ more staff*" (Appointment.Worker1)

The manager stated that no specific qualifications are required to work in the Appointment Team, asserting: "*having attention to detail and being diligent in the work is the key skills we look for.*" (Appointment.Manager1)
Appointment.Worker2 said that no specific skills are necessary because documented training guides are available to explain everything that needs to be performed.

> "*You can follow the guide, it is a dummy guide as they say, step by step, screen shots, you can't go wrong*" (Appointment.Worker2)

Appointment.Worker1, explained this is an administrative process and the main skills required are knowledge of Microsoft Excel and Visual Basic, including fixing issues with spreadsheet macros, using emails, Microsoft Office products and running reports on the Recruitment system. Training is provided in running reports, but knowledge about other areas of the Recruitment system is not necessary.

Managers attended a presentation arranged by the IT department in December 2018 to explain what can be achieved with process automation technology. Following this session, Appointment.Manager1 put forward the NAF process for automation. The manager believed the NAF process was a good candidate, because the task was routine, only used information held in the Recruitment system and was an activity that was consuming a lot of the workers' time.

4.3.2 Constraints and Challenges: Appointment

All the participants reported that the main challenge with the process was the volume of requests received, making planning difficult. The manager stated that the NAF activity was meant to be a small element of the workers' role and over time this had overtaken all other duties. The nature of the work is very routine and repetitive. Being able to manage the present and future demand placed on the team was important.

> "*the main challenge being the volume of requests we need to process… free[ing] up... the worker to do other duties we want them to look at… The person doing that role weren't given the opportunity to use their other skills and get involved in other projects.*" (Appointment.Manager1)

4.3.3 Expectation of Automation: Appointment

All interviewees expect the output from the automation to be an improvement on the present manual activities, with Appointment.Manager1 commenting: "*if we can release the worker to do other activities then that would be a big step forward*"

Appointment.Worker1 also expected the automation to help the team meet their key performance targets for the number of records processed and to improve the customer satisfaction survey scores on how the team deals with telephone and support queries. In the case of Appointment.Worker2, they believed the automation not to change anything apart from the present activities being performed more quickly and consistently, saying:

> "*[the expectation is] the same delivery I was doing really because at the end of the day it is about producing the same output in a consistent, timely and accurate manner.*"

The managers did not anticipate that automation would result in losing staff, rather that it would free workers to perform other duties, such as dealing with telephone queries and resolving any appointment issues that they did not have the time to complete and to allow the present NAF service to be offered to the remaining health organisations and departments in Wales. Appointment.Manager1 explained

> "*we are not looking to lose staff, we are simply trying to make full use of existing resources to handle ongoing demands*"

Appointment.Manager1 expected automation to be at level three (up to 75% performed by automation) because they did not believe that BPAuS could correct errors or use any additional information held in the Recruitment system. For instance, a note might be placed on the recruitment record to say the starting salary should be overridden with a revised starting salary, BPAuS would not know to use the revised information to complete the task. Both workers envisaged the level of automation to be delivered by BPAuS to ideally be at level four (up to 99.9% performed by automation). They believed that if the Recruitment system was correctly kept up to date and the process was watertight, BPAuS should be able to use the latest information from Recruitment to generate the NAF. The only exception would be if there were issues with the Recruitment system which it would require someone to investigate.

4.4 Case Study 4: Roster (Roster Shift Pattern Payment)

4.4.1 The Department: Roster

This case study focuses on an activity undertaken in the Rostering Team in organisation B. The small Rostering Team is responsible for ensuring shift cover is provided for wards across all the organisation hospital sites. The Rostering Team works with hospital wards to provide relevant health roster shift cover for nurses and doctors when these are required. Activities include managing agencies that provide shift workers, liaising with hospital wards on shift cover requirements, including roles available, when cover is required, duration of cover and any overtime payment considerations. The Rostering Team is also responsible for advertising the shifts on the NHS web site, managing shift enquiries, liaising with the wards on the candidates available and managing the shifts assigned to a worker. This includes entering the shifts allocated to a worker on the Rostering system and entering the payment details, including hours to be worked, rate of pay on the Finance system. The Finance system then generates the purchase order to the agency and manages payment of the invoice received. The Rostering Team also works with the Accounts Payable (AP) department at organisation A and the Finance department at organisation B because of invoice queries received and to reconcile payments made to agencies against the shift worked.

The number of shifts advertised and managed has steadily increased each year. At the time of the interviews there were over 1,800 new shifts processed every week, involving 31 agencies providing shift workers. Entering the shifts into the Rostering and Finance systems was estimated to take 90 hours per week. Cancelling and amending the shifts in the Rostering system was estimated to take 6 hours per week. About 1,400 shift payments were receipted in the Finance system every week, estimated to take 30 hours to complete. The volumes of shifts being processed required three staff, each staff working 30 hours per week for two weeks every month. Managing the data entry for the 3,480 tasks in the Rostering and Finance systems was estimated to be taking 126 hours per week (6,500 hours per annum), equivalent to 3.6 FTEs.

The Rostering Team comprised of 3 workers on a salary grade 2 (salary range £17k to £18k) and grade 4 (salary range £20k to £23k). The department had also been using a full-time temporary admin agency worker for two years on a grade 4 salary to help with the workload of the team. The workers are responsible for managing telephone queries, updating the systems used (rostering, finance, web site, and scheduler), verifying timesheet submissions of shifts worked, and ensuring relevant controls are in place. The manager has responsibilities for managing the department, dealing with disputes, matters escalated by workers, wards and agencies and to promote the services of the Rostering Team and good practice across hospital wards. The manager also deputised for the workers when support cover was required due to sickness/absence and assisted with processing and checking shifts during periods of high workload.

The workers do not require any specific qualifications or skills to perform the role. Roster.Manager1 said having a background in nursing was helpful to understand the activities although not essential. Staff are expected to have general IT computer skills, understanding of Microsoft Excel and emails. Training is provided on all the relevant systems used, for instance the rostering and the Finance systems.

The Finance department approached the Rostering Team to improve their financial controls and reporting on agency payments. This review included addressing a range of issues that was placing additional strain on the Finance department. The issues included the way orders were raised, amended, cancelled and receipted. The Finance department contacted the central development team who had skills in building automation and asked them to identify whether automation could assist the Rostering Team with any aspect of their present process.

4.4.2 Constraints and Challenges: Roster

There were a number of challenges with the present activities. One of these was the difficulty in predicting demand for shifts and processing the shift requests in a timely manner. For instance when workers phoned in sick then it was usually necessary to provide cover for the ward the same day. However, Roster.Manager1 stated that:

> "*The bigger challenge is when the shift worker works different hours to the shift originally agreed*"

When this happens, additional tasks need to be performed, such as checking the reason for the revised hours, validating the revised timesheet with the ward manager and updating the Rostering and Finance systems with the revised hours worked. This process can be time consuming, involves the worker prioritising their activities and mistakes were happening. The Rostering system was viewed as more critical than the other systems used, such as the Finance system. Consequently, staff spent the majority of their time ensuring this system remained up to date on new shifts and any changes to shifts. Less time was spent keeping the Finance system updated to process the orders, cancel or amend orders and confirm payments. Pressure meant that sometimes incorrect information was entered in the Rostering system resulting in timesheets and agency invoices not reconciling with the information provided in the Rostering system. This led to invoices being placed "on-hold" until investigated.

The back log of invoices meant that only 27% of invoices were paid on time. Agencies were frustrated with increased telephone calls querying payments. There were sometimes issues with invoices that were paid not reflecting the hours actually worked and credit notes being requested to recover overpayments or sometimes a further invoice being requested to cover any shortfall due to the agency. This in turn created further work for the Rostering Team. Many of these issues impacted on the Account Payable (AP) department who are responsible for paying all suppliers. Agencies were irritated and also phoning the Accounts Payable department querying their invoices requiring a resource of 0.2 FTE member of staff. This also placed pressure on the Finance department that had no visibility on the amount being spent with agencies, made budget planning difficult, with Finance staff having to make manual journal adjustments in the systems. For the Finance department, this work was consuming 0.13 FTE resource of a salary grade 3 and 0.10 FTE of a grade 6 worker, estimated to cost a total of £6.23k per annum. The backlog of invoices meant that there were also missed opportunities to check and recover credits from agencies for overpayment.

Although the number of shifts to be processed had steadily increased, Rostering Team staffing had not increased to reflect the additional workload. The present situation was deemed untenable, with Roster.Manager1 reporting that: "*It can be soul destroying for staff, when they have to process 1,800 invoice lines*"

The situation was creating many issues for the department, with some agencies stating they would not provide shift workers if invoices were not settled in a timely manner. There was also the constraint of managing additional shifts and working with additional agencies to provide potential workers when these were required.

Roster.Manager1 stated that the process to update the Finance system to raise orders, amend orders, cancel orders and receipt orders is labour intensive, time consuming but a very straightforward process, and it was viewed as a good candidate for automation. However, the manager recognised that workers were initially fearful when they were informed about the plans to automate some of the tasks. It was unclear to them what it meant for their jobs and as a result, they were not on board with this initially. This may be because the move to automation came from the Finance Team and not the Rostering Team. Roster.Worker1 commented:

> *"I was sceptical as I didn't know what this meant or if it would work or what it meant for my role. If it didn't work then who would have to sort out any mess as we were already working under a lot of pressure."*

4.4.3 Expectation of Automation: Roster

Roster.Manager1 expected the output from the automation to be agencies being paid in a timely manner, the quality of data captured on both the Rostering and Finance systems to be up-to-date, accurate, consistent and complete. This was anticipated to lead to improved accuracy of agency spend, timely receipting of invoices, reduction in overpayments and improved timeliness of management information. As a result, this was thought likely to reduce pressure on existing staff, support future growth in shift management and to also reduce the pressure placed on other departments in the Health Board, including the Accounts Payable and the Finance departments.

> "*if … we only pay agencies what is owed and reduce the number of agencies getting frustrated…. then that would be a good outcome*." (Roster.Manager1)

There was recognition from the interviewees that BPAuS would not do it all and that workers would still have to manage the suppliers. Consequently, Roster.Manager1 expected the level of automation to be at level three (up to 75% performed by automation). There was no expectation that BPAuS would change the role or the skills needed. Roster.Worker1 also expected the level of automation to be at level three, and was unclear about what this meant for their role or skills.

4.5 Case Study 5: Contract (New Staff Contract)

4.5.1 The Department: Contract

This case study explores an activity undertaken in the Onboarding Team of organisation A. There are three regional Onboarding Teams, each team is responsible for ensuring new employment contracts are prepared for staff joining a health organisation or moving into a new position. There are a number of pre-employment activities performed by the Onboarding Teams to support the creation of the contracts. These include checking candidates' qualifications, references from previous employments, ensuring occupation health screening is completed and all relevant supporting information is provided and verified. Once these checks are completed, the line manager for the new employee is contacted to request they agree a start date with the candidate. The line manager must notify their Onboarding Team of the start date so that the Recruitment system and Payroll system can be updated. The Onboarding Team will check that no further information is outstanding in order to prepare the employment contract. The Onboarding Team employs 39 staff across the three regions. A number of these staff are temporary bank/agency staff to provide flexibility when demand necessitates this to meet target completion dates for new contracts.

The Onboarding Team create on average 850 new contracts every month for the 15 Health Bodies in Wales. Each contract can take about 20 minutes to prepare, except the more specialist roles that can take significantly longer. Managing the data entry for the 10,200 new contracts per annum was estimated to take 3,400 hours per annum, equating to about 1.89 FTE staff. The target was to issue the employment contract within the statutory 8 weeks from the date the employee starts in post. It was recognised this delay in issuing contracts was not ideal, however it reflected the lead time necessary given the workload and demands placed on the Onboarding Team. The bank/agency staff were full time and tasked with only creating employment contracts, processing between 30 and 40 a day. The remaining workers process between one and two contracts a day alongside their other duties. These duties include checking the qualifications, references, ensuring the relevant Occupation Health Check assessments have been undertaken, ensuring the Recruitment and Payroll systems are up to date. However, this could vary depending on demands and deadlines.

At the time of data collection, the workers were on a salary grade 2 (salary range £17k to £18k) and grade 3 (salary range £17k to £21k). No specific qualifications are required to work in the Onboarding Team, as the Contract.Manager1 stated: "We *just need people that have the right aptitude to do the job*." The workers agreed that no formal qualifications were needed for the role, however all the workers have one or more GCSE qualifications, with one worker also having an undergraduate degree. Contract.Worker1 asserted:

> *"having good customer service skills is important for the job as you have to deal with a range of people"*

The managers expect workers to have basic skills in using a computer, Microsoft Office products and emails. Workers are provided with relevant training to use the Recruitment system and Payroll system to perform the tasks. Attention to detail and being focused on the activity is essential in order to avoid critical mistakes.

Managers from the Onboarding Teams attended an awareness training course arranged by the IT department in November 2018 to explain the process automation technology. The aim was to provide insight for managers to identify processes potentially suitable for automation. Following the training, Contract.Manager1 put forward the creation of the employment contract for automation because the task was viewed as time consuming and straightforward since it involved taking information already collated and stored in the Recruitment and Payroll systems to populate the relevant contract template form. Contract.Manager2 described the activity as: *"mundane and routine tasks that are not adding any value to us"*

The managers felt it would also allow the remaining workers to have more time to progress the pre-employment checks and deal with telephone queries received from candidates and line managers. Contract.Manager1 also felt that:

> *"if it [automation] allows us to free up needing the full time bank staff then that would be helpful"*

The manager did not want contracts for specialist positions, for instance medical roles or very senior managers to be automated. This was because the work to prepare the contracts was not straightforward as the contracts were tailored to the relevant organisation requirements.

4.5.2 Constraints and Challenges: Contract

Contract.Manager1 stated that the task to create a contract is critical: there is a statutory obligation to have a signed contract for each employee and they had to be issued within a reasonable period. The difficulty for the Onboarding Team was that the volume of contracts varies each month and this creates workload management challenges. The Onboarding Team use a scheduler application to remind them when they must issue the contract within the statutory 8-week period.

Although quality checks are performed to ensure the contract contents are accurate, mistakes do happen because of work pressures and the backlog that existed in the department at the time of the research. The Onboarding Team receive queries from line managers and employees about the contract and the details provided, the majority relating to incorrect information. The mistakes can arise for a number of reasons, for instance the information held on the Recruitment system or Payroll system was incorrectly entered or missing; the start date for the employee had changed but not communicated to the Onboarding Team; the employee residential address had changed. In these situations, the Onboarding Team update the contract and then reissue for signing.

Contract.Manage1 wanted a more intensive way of completing the activity without needing to use as many workers to perform the task. They remarked that if we did not believe automation could potentially add value then we would not have considered it. If most of the activity to create contracts could be undertaken by BPAuS, Contract.Manager1 commented:

> "*Potentially 7 FTEs [whole time equivalent staff] released to undertake added value activities within Employment Services.*"

4.5.3 Expectation of Automation: Contract

The expectation from automation was to ensure BPAuS can generate the contract accurately, consistently, and in a timely manner. Contract.Manager1 still expected some elements of the current activities to be a manual process, for instance when there is information missing from the application. Consequently, when the managers were asked what level of automation they believed would be delivered by BPAuS, both said level three (up to 75% performed by automation).

> "*We are hoping that about 75% of the contract will be captured by the robot*" (Contract.Manager1)
>
> "*The robot is not going to be able to deal with a contract query.*" (Contract.Manager2)

Both managers said the 25% of the contracts not suitable for BPAuS would continue to be performed by the existing workers. The workers were made aware of the process put forward for automation and were keen for any solution to help with the present backlog contracts. Two of the workers (Contract.Worker1 and Contract.Worker3) also expected the level of automation to be level three. These workers felt someone would still have to sort out the data, correct any errors and input the correct data into Recruitment and Payroll systems. They did not believe BPAuS would have the knowledge to do this. Contract.Worker2 believed BPAuS could only generate the contract and not do other bits of the job, suggesting *"there are a lot of checks as part of the process"*

Contract.Worker2 said that if the automation was to generate the contract using only the data held in the Recruitment system and Payroll system, then they expected this to be straightforward for the automation and expected the level of automation to be level four (up to 99.99% performed by automation).

4.6 Case Study 6: Payroll (Hire Applicant Process)

4.6.1 The Department: Payroll

This case study explores an activity undertaken in the Payroll Team of organisation A. The Payroll Team comprises of 8 staff and have responsibilities for ensuring new appointees are correctly setup on the Payroll system to receive a salary, expenses and any other remunerations based on the terms of their employment.

As part of the appointment process, the hiring managers complete a New Application Form (NAF) with the appointee. This form confirms the appointee's job title, starting date, grade, paypoint and other supporting information such as bank details and home address. The hiring manager returns the NAF to the Payroll Team. When the form is received, Payroll Team check all the details on the form are correct and if everything for that appointee has been provided, the Payroll Team calculate the starting salary, the tax code for the appointee, obtain the assignment information and determine any student loan details. This information is then checked by a supervisor before the payroll record is created on the Payroll system and on the Expense system. The Payroll Team notifies the hiring manager by email when the appointee has been setup on the Payroll system.

The hire application process for the Payroll Team is performed by eight workers, five full time Payroll Support Officers on salary grade 4 (salary range £20k to £23k) , with all the work supervised by three full time supervisors on salary grade 5 (salary range £23k to £29k). Daily the workers spend about 50% of their time processing hire applications, including around 150 external hire applications per year. The creation of the 750 applicants per annum was estimated to take about 4,500 hours (2.5 FTE staff).

All the interviewees agreed that no specific qualifications are required to be a Payroll Support Officer, with training provided in areas such as understanding the Revenue and Customs legislation regarding tax, and national insurance and the Agenda for

Change paypoints. Training is also provided on using the Recruitment system and Payroll systems used to process the payroll information.

The workers have to understand Microsoft Excel and Outlook to process emails. It is assumed new workers have these skills and this is assessed during the interview process. Payroll.Worker1 indicated that being patient, being able to organise work and being able to work under progress are the more important key skills workers need for the role. The Payroll.Manager2 confirmed this:

> *"The main thing we look for is people with the right aptitude and attitude and we then provide all the relevant training"*

Payroll managers from the four sites attended a presentation arranged by the IT department in December 2018 to explain the work they are doing on process automation. Following this session, the managers put forward the hiring application process for automation. The managers wanted to automate the process but only for external applicants (i.e. appointees not presently working for the same organisation) rather than internal applicants. The payroll process for internal applicants is more straightforward with only a small number of activities and therefore, at this stage, the managers did not view them as important as the process for external applicants.

4.6.2 Constraints and challenges: Payroll

Payroll.Manager1 identified a number of challenges with the present process, including ensuring tasks are completed by a specific date. Staff are paid on the 23rd of every month and therefore the Payroll Team must complete all their checks, do all the tax and other calculations as well as setup the new appointees on the Payroll system by the 15th of the month for the staff to be included on the payroll feed to be paid that month. Payroll.Worker2 commented:

> *"If we miss it [the 15th of the month] then the new staff have to wait until next month to get paid unless we do an emergency payment run to ensure there is no financial impact on them"*

A further challenge reported by managers was that the organisation was planning to move onto the new Microsoft Office 365 spreadsheet system and it was unclear whether the existing NAF spreadsheet document that uses macros would still work.

These macros are important because they provide security control over what data the person (appointee, hiring manager, payroll staff) accessing the spreadsheet can view.

4.6.3 Expectations of Automation: Payroll

All interviewees have similar expectations on the output expected from the automation, in particular for the automation to process a greater volume of records to speed up the payroll process and to be able to free the workers to allow them to focus on the customer engagement side of their role. Payroll.Manager1 remarked:

> "*We are hoping that the robot can run more frequently, do more timely checks and therefore our offload deadline can be extended or possibly be removed*"

The managers added that a further aim of the expected automation was to roll out the same process to the remaining three payroll sites. This would also support a larger project by the Payroll Team to deploy a standard NAF across Wales and if they could automate the payroll element for one payroll site they were hoping this would be adopted by the remaining sites. The additional reason for automating the process was because of the high turnover of payroll staff because of the low salary grade and limited career progression, the constant need to train new staff as well as the changing volumes of NAF to be processed.

The two workers were not sure what to expect in terms of the outcomes from the automation, however they were intrigued to see what BPAuS could achieve:

> *"the more the robot can do to assist us the better but I am not sure how far they are looking to take the robot. It does excite me but I would say I am intrigued at the moment"* (Payroll.Worker2)

.

Payroll.Worker1 put it like this:

> *"I would hope it will make it easier for us and allow us to more interesting work but we will have to see."*

In terms of outcomes expected from the automation, both managers were expecting the automation to free about 50% of the time the five workers presently spend doing the specific routine and repetitive tasks: "*If it also reduces the time the 3 supervisors spend checking the work then that is also great"* (Payroll.Manager1)

The managers' expectation was for the workers to focus the time saved on addressing quality matters with the process, for instance overpayments. A lot of information was also received late from other departments and hiring managers and this meant payment runs for new appointees were being missed for that month. These activities could only be progressed if the workers have the time to complete the task.

All the participants expected the level of automation to be delivered by BPAuS to be at level three (up to 75% performed by automation). The two managers were reviewing their present process and all the decision points were not fully mapped out to know what tasks would still require human intervention and what tasks were more suitable for BPAuS. The two workers felt that there was still a need to quality check the data being received from hiring managers and to ensure that all data held in the Recruitment system and on the NAF form was correct for BPAuS to use, therefore they did not believe all the tasks could be fully automated.

4.7 Cross Site Summary

A detailed comparison of key themes across the sites is provided in Appendix F. The incentive for introducing automation technology at each of the sites varied. A common theme was to free workers to create capacity to carry out activities they did not previously have time to complete, such as improving quality of service with customers and suppliers. At the Statement site a further incentive was to recover missed income not being realised. At the Appointment site and Rostering site, an incentive was to manage the additional pressures on workers that can arise during periods of high demand and the ability to manage this within existing resources rather than having to take on temporary workers. One of the challenges with taking on temporary workers was the time needed to train and support the workers. At the Rostering site, the request for the Rostering Team to consider automation came from the Finance department because of the extra work being created in the Finance Team to correct the mistakes the Rostering Team made in entering the shift details in the Finance system.

Across the sites, the whole job was not being considered for automated, with the focus on identifying relevant tasks for automation. The only exception was at the Roster site where they felt the whole job performed by the temporary workers was limited to a specific set of simple tasks. At the sites, the types of tasks selected for automation was those that were simple, routine and repetitive to perform. This aligns with Ford (2015) and Autor (2015) assertion that the most suitable tasks for automation are those that are routine, repetitive and require little judgement to perform. One of the reasons for the sites limiting the tasks selected was to understand the capabilities of the new technology before considering any further tasks that were more complex or demanding to perform. For instance at the Contract site they wanted the automation to focus on the standard new starter contracts only. At the Payroll site, the automation was to only progress the payroll for external applications. Across all the sites, the nature of the job did not require workers to have any specific qualifications or skills to perform the tasks and tended to be lower paid workers. There was also limited impact expected on supervisors and managers. The impact on lower paid workers support Arntz et al. (2016) position on automation that it is tasks that are automated not the whole jobs.

Table 6 details the effort to perform the present tasks across all six case study sites and the extent the tasks form part of the workers job. There were no expectation on the number of hours expected to be saved. This may be due to the new nature of the automation technology and uncertainty to what could be achieved.

There is a mixed views across all the sites on the level of automation (LoA) expected (see Table 9). None of the sites expected the LoA to be level five (100% performed by automation). This may be because there is an expectation the automation will need to be supported if something goes wrong. At three of the sites (Statement, Roster and Payroll), the LoA expected to be level three (up to 75% performed by automation). At the Appointment site and Contract site, the managers expected the automation to be at a lower level than the workers. The reason for the different views is unclear and may be due to uncertainty to what could be achieved and to what extent the task and process would be automated.

Table 6 – Pre-Automation summary findings across the case study sites

Case Study Site	**Task size and effort to perform manually (per annum)**				**Whole job or a specific process task to be automation**
	Number of items processed	**Hours to complete task**	**Full time equivalent staff**	**Number of workers sharing task**	
Site 1: Statement	Varies	1,320	0.73	2	Specific task to be automated Task is circa 36% of a workers job Task and data to be processed is simple
Site 2: Catalogue	5,200	1,040	0.58	3	Specific task to be automated Task is circa 19% of a workers job Task and data to be processed is simple
Site 3: Appointment	240	960	0.53	2	Specific task to be automated Task is circa 26% of a workers job Task and data to be processed is simple
Site 4: Roster	3,480	6,500	3.6	3	Entire process (finance) to be automated Task is 100% of a workers job Task and data to be processed is simple
Site 5: Contract	10,200	3,400	1.89	38 (not equally)	Specific task to be automated and limited to non-specialist contracts only Task is circa 1% of a workers job Task and data to be processed is complex
Site 6: Payroll	750	4,500	2.50	5	Specific task to be automated and limited to external applicant records only Task is circa 50% of a workers job Task and data to be processed is complex

4.8 Conclusion

This chapter presents the pre-automation stage, examining the reasons for considering the technology and the expectations from automation. The selection was driven by the capabilities of the BPAuS technology which is limited to activities that do not require judgment to be made, the task is routine and the activities can be mimicked by a computer. In all cases except the Rostering site, the task chosen for automation would normally be a subset of the workers job. During periods of high workload demand these tasks would be performed as a specific job by temporary workers. In these cases, the only job loss identified was the recruitment of temporary workers to support the department during periods of high workload demand.

Common themes can also be identified in terms of the expectations of what the automation would deliver for the department. None of the managers or workers expected every aspect of the task could be automated. In the majority of cases, the expectation was for the level of automation expected to be achieved to be up to 75% automation (level three, refer to Appendix C). In all cases, there was an expectation that the automation would free workers' time to focus on other activities, for instance deal with customers and address data quality issues, with the records being processed by the automation, ensuring they were up-to date, complete and accurate. In two case studies (Contract and Roster) there was an expectation that the automation would reduce the number of workers required.

Chapter Five: Case Study Findings II – Post-Automation

The chapter explores what was involved to build the automation and the impact of any implementation on workers and managers. The first two research questions are explored, namely to evaluate the main determinants that influenced the deployment of BPAuS technology, how these determinants compared to the reasons for wanting to deploy BPAuS and how the use of BPAuS technology affects job characteristics (task variety, responsibilities and job demands), work characteristics (challenges, resources, output and outcomes) and skill sets (job complexity, qualifications and skills). These are examined through analysis of the interviews and questionnaire responses that took place several months following the deployment of the technology in four teams (case studies 1 to 4) and where the project moved into abeyance in two teams (case studies 5 and 6).

The findings for each case study are structured into three sections. The first section details the activities required to build the automation and any issues and challenges arising with creating BPAuS. For the four sites (Statement, Catalogue, Appointment and Roser) where the automation was implemented, the second section reviews what the automation has meant to managers and workers several months after the implementation. This is examined in terms of perceived challenges and benefits, the level of automation delivered, resources needed and any impact on job, work and skill characteristics. For the two sites (Contract and Payroll) where the automation was not implemented, the second section reviews the reason why the automation moved into abeyance. The final section summaries the key finding for the site. Section 5.7 provides a comparison across all the sites to review what has changed pre-automation and post-automation. The final section (5.8) provides concluding remarks about the findings.

5.1 Case Study 1: Statement (Supplier Statement Reconciliation)

5.1.1 Automation Build: Statement

The IT development team worked with the Statements Team in April 2018 to understand the existing process, review the work instructions, process maps and procedures to ensure sufficient information was documented to allow the existing manual process to be replicated using automation. The review identified it was necessary to update the work instructions to capture more details about the steps performed. The details that had to be added included capturing all keystrokes performed by the worker and the details of all the forms/screen that were displayed. It was also necessary to capture all the scenarios of what could go wrong with the task (for instance, if there was a problem connecting to the network) and to detail how each of these scenarios had to be addressed. This was necessary because BPAuS follows pre-defined logic that has to be programmed. The logic replicated the workers' keystrokes and set out what to do in the event something went wrong with the task.

The managers recognised that updating the documentation was a considerable amount of work, but understood this was necessary to programme the automation. It took about a month and once accepted by the development team, BPAuS build commenced. The build was an iterative process between the Statement Team and development team, with the managers regularly reviewing what was built and preparing suitable test data files to validate the automation worked as expected. The build and testing cycle was repeated until the development team was satisfied that BPAuS worked and the managers reviewed and accepted the outcome produced by the automation. There was a final test phase using a copy of a live data file from one supplier to ensure BPAuS successfully worked in this situation. Only once the development team and managers accepted the final testing outcomes did the managers make the decision to deploy BPAuS in the live environment.

BPAuS was initially deployed in September 2018, however, the managers reported that there were issues almost immediately with the automation always failing to reconcile a supplier statement. One of the reasons identified for the failing was the format of the data files provided by suppliers. Although some of the format changes could be ignored when a worker performed the task, unless the scenario was programmed into BPAuS it did not know how to handle the situation and stopped working. For example, as explained by Statement.Worker1, some suppliers added columns to the Microsoft Excel file or changed the order of the columns, rather than using the pre-defined format. In these instances, the workers had to reformat the columns to realign these to a standard format that BPAuS was expecting. These specific scenarios were not tested when the automation was being built because the significance of these subtle file changes was not understood at the time. Statement.Manager1 said they took the decision to "*get it working with one supplier… and work from there*". Every step of the automation process was manually checked by the development team and the Statement Team. The phased approach to test all of the specific scenarios that could arise and to programme these into BPAuS was to ensure the automation did not add to the workers' existing workload. BPAuS went live and processed the 50 suppliers' statements in December 2018. The time taken to resolve issues and fully deploy the technology was 4 months.

Statement.Manager1 recognised that the process of building BPAuS was not straightforward and put it like this:

> *"it has not been as smooth as we expected...[the Statement Team had to] do more work than was originally envisaged".*

5.1.2 Automation Implementation: Statement

When the interviewees were asked what the change meant for them, all agreed that there were some common issues. These included failing to find supplier invoices on the Finance System and difficulty understanding why the automation could not complete a task, with Statement.Worker1 stating it was sometimes difficult to "*interpret why the robot may have failed to reconcile a statement*". On further investigation, it was identified that the automation could not clearly distinguish between some of the characters, for instance the letter 'o' and the number '0' (Statement.Worker2). The data had to be completely accurate for the automation to work and the staff had to do considerable work to correct the data for BPAuS to work.

> *"[the workers] needed to spend more time to prepare the data for the robot to use*" (Statement.Manager1)

A further challenge related to suppliers changing the format of some of the data items. Statement.Manager1 described it like this:

> "*[the supplier statement files] missed key information to identify the invoice… or they [the supplier] added an extra letter to the invoice number".*

The workers reported issues with different date formats in the same supplier files that needed to be converted to dd/mm/yyyy; additional characters/information appended to invoice numbers that could stop the matching process from working. However, the workers had to spend time preparing the data files, this was regardless of whether the task was done manually or by the automation. Both workers reported they had expected the automation to be able to handle more of the different types of data formats provided by suppliers, in particular reading data from PDF documents or from the email. When asked why this was not the case, Statement.Worker1 commented that the development team felt it would be too complicated for the automation to handle and therefore this had to remain a manual activity. Statement.Worker2 reported that on occasions it was "*more accurate to manually reconcile*" the full statement than to use BPAuS, although Statement.Worker1 confirmed that "*[BPAuS still] saved time*" when it worked with good data.

Statement.Worker2 reported that as a consequence of the automation, the workers were spending more time up-front checking all the data records to ensure the information was correct – "*more work needed to be spent preparing the data for the robot to use*". Spending this additional time to support the automation was believed to reduce the number of issues for the automation. This rebalance of where the workers spent their time was necessary to allow the automation to do the reconciliation work. Despite the challenges, the managers reported the automation had freed the workers to undertake other duties. However, they did not believe the workers' job role or skills had changed In contrast, the workers felt they had learnt new skills and had taken on new responsibilities to manage BPAuS. Statement.Worker2 stated that using the automation had "*improved my skills in troubleshooting issues*" when there were issues with the automation, making the job more satisfying. A new responsibility added to the workers' existing role was to problem solve issues when the automation failed to work: *"the need to problem solve was a new duty added to a worker's role"* (Statement.Worker3). To provide confidence in the automation, the workers had to also undertake spot checks to ensure there were no errors with the BPAuS outputs.

When the interviewees were asked what level of automation was actually delivered compared to what they expected, the managers reported they still felt it was level three (up to 75% performed by automation). A number of reasons were stated for this, including "*still need to do a lot of work up front to get the data ready for the robot"* (Statement.Manager1).

Both workers reported that they felt the level of automation actually delivered was less than they previously expected, stating it was now level two (up to 50% performed by automation), with Statement.Worker1 asserting that: "*we still have to initiate when the robot runs and spend time to get the data sorted*".

The difference in opinion between the two groups is understood to be because the managers were not aware of the extent the workers were having to solve issues and fix BPAuS when it stopped working.

All interviewees highlighted that the automation had provided some benefits for them. When the automation worked, it worked well

> "[the] *robot has been great and saved us from having to do the [statement reconciliation] job*" (Statement.Manager1)
>
> *"the robot has been well received, it has definitely helped….. [It has] saved us time…[allowed us to do] other activities that we wouldn't otherwise have had the time to do"* (Statement.Worker1)

The automation had freed capacity to increase the number of supplier statement reconciliations processed from 50 to at least 100. The managers reported that the automation had provided timely and additional information to suppliers about the status of their invoices. Although the intention was to reduce the number of supplier phone calls to the Statement Team, what the Statement Team had found is that new types of queries are now being raised, with Statement.Worker1 remarking:

> "*they [suppliers] are phoning to ask questions about other matters.. and more questions based on the information now being provided*".

The automation had provided some unplanned benefits for the Statement Team, such as agreeing early repayment discount terms with suppliers, especially when no issues were identified with the invoice by the automation for the invoice to be paid earlier in return for a credit saving back to the NHS. The managers and workers could see benefits of the automation and had become dependent on BPAuS, with Statement.Manager1 saying:

> "*[the team are] now reliant on the robot being there to take some of the pressure away from staff*".

One of the supporting documents provided by the manager was details of the time spent on tasks. Before automation workers spent 1,320 hours per annum and following automation this was reduced to 550 hours, delivering 770 hours (0.42 FTE staff) savings for the Statement Team. This was confirmed by Statement.Worker1 who said: "*[the robot has] reduced the time taken to complete task by approximately two thirds*". The time still being spent on the task by the workers were to analyse all the data files provided by the suppliers and correct any data missing and when necessary to restructure the file for the automation to use.

The managers stated that to allow all workers to have more assurance with the automation and to maximise the benefit of BPAuS, it would be helpful to extend the automation to deal with more data issues, before looking to extend the automation to process any more supplier statements and to manage more processes.

5.2 Case Study 2: Catalogue (Supplier Catalogue Extension)

5.2.1 Automation Build: Catalogue

The development team worked with the Catalogue Team in November 2018 to understand the existing process, review the work instructions, process maps and procedures to ensure there was sufficient detail documented to allow the existing manual process to be replicated using BPAuS. The review identified that the work instructions did not have sufficient information to allow the process to be replicated by BPAuS. Additional information included all keystrokes performed by the worker, details of all screens and images that would be displayed, identification of scenarios of what could go wrong with the process and the details how each of these situations could be addressed. A considerable amount of work was necessary to update all documentation by the Catalogue Team.

The review of the documentation also resulted in the managers reviewing the existing business process and questioning every step to determine whether any steps were superfluous. The review identified opportunities to streamline some of the existing process which was actioned before any automation was considered. For instance, Catalogue.Manager1 stated that another team would previously generate the supplier report from the Procurement system and export the data into Microsoft Excel file. The file would then be used by workers in the Catalogue Team to search for the supplier in the same

Procurement system. This activity no longer needed to happen with BPAuS because BPAuS could be programmed to search for each supplier in the Procurement system, so removing two steps from the manual process, and requiring no report to be exported into Excel.

Once the documents were accepted by the development team, BPAuS build commenced. The development of the automation was an iterative process, involving the development team using test data provided by Catalogue Team to confirm BPAuS worked as expected with different sized data files. Once Catalogue.Manager1 was satisfied that BPAuS was updating the Procurement system correctly using a wide range of data scenarios, the managers and development team agreed for the automation to be deployed in the live environment.

BPAuS was deployed in January 2019 and until early March 2019 the automation worked well. However, in March Catalogue.Manager1 stated that BPAuS started to fail most of the time, saying "*it was atrocious, we had a 55% fail rate with the robot*".

Between March and mid-May 2019 the workers had to resume to performing the task manually whilst the development team investigated the reasons for the automation failing. The problem was identified to an update to the computer operating system from Windows 7 to Windows 10 used by BPAuS rather than due to data. . The upgrade created intermittent issues that required changes to connections and updates to the software used by BPAuS. When the issue was resolved, the full implementation of the automation was delivered in June 2019. The time taken to resolve issues and fully deploy the technology was 6 months.

5.2.2 Automation Implementation: Catalogue

When the interviewees were asked what the change meant for them, there was a mixed response. The managers felt the automation had not been stable enough to say whether it had really changed anything for them. It was a challenge to understand why the automation failed and what needed to be corrected. The concern was that any issues created additional work for the workers. Catalogue.Manager1 commented that:

> "*we need to understand what has happened….to ensure we can fix these issues otherwise it is creating more work for us*".

Catalogue.Worker1 reported that there was a lot more work required to check the data before the file was passed onto BPAuS. The checks included ensuring all the new expiry dates are in required dd/mm/yyyy format and no new columns had been added to the file. These checks are an extension of the work already taking place by the workers when reviewing the files. There was also a validation check added at the end of the process when BPAuS had finished. This was to confirm that the automation had successfully completed its tasks correctly. When BPAuS stopped working for several months, the workers were not informed of the reasons for the issues and had to revert to manually performing the task. When informed they had to perform the task manually, Catalogue.Worker2 was pleased because performing the activity had been part of their set routine:

> "*When I was told it was going to be given to a robot then I was disappointed. Yes, it is a boring task but….I enjoyed it. I was actually pleased [when the robot failed].*"

Although there was work required early in the process to check the data, Catalogue.Manager2 believed this was just moving the point in the process these checks were carried out and therefore did not view it as creating more work.

All of the interviewees did not believe the nature of the job or skill required have been affected by the automation.

> "*this task is very simple and doesn't require any detailed understanding… this task is only a subset of the [workers] job role*" (Catalogue.Manager1)
>
> "*the only change is rather than extending catalogues I can now cleanse more catalogue…[and] taken some of the stress and pressures off me*" (Catalogue.Worker2)

The managers stated that the biggest change for the workers was that they now have more time to progress the other activities within their existing responsibilities, with Catalogue.Manager2 explaining: *"I suppose they [the workers] will be less stressed during that week now I guess"*.

Workers were still performing validation checks once the automation had completed its process to provide reassurance that it worked as expected. There were still activities required by workers to deal with issues reported by BPAuS, sometimes data-related and other times due to system or machine issues. This in turn created new unplanned responsibilities for the operational staff.

When the interviewees were asked what level of automation was actually delivered compared to what they expected, managers stated level two (up to 50% performed by automation) rather than the level four (up to 99.9% performed by automation) they originally anticipated. The reason for the change was due to the ongoing issues with BPAuS. The managers said that once the automation performs as expected then they may consider it moving to level three (up to 75% performed by automation) but not higher because there would still be work necessary to prepare the data for BPAuS to use.

All the workers reported the actual level of automation delivered was lower than what they expected. Two workers reported level three, down from the expected level four because BPAuS had not been working successfully for long enough and manual work was still required. Catalogue.Worker3 stated level one (up to 25% performed by automation), because they felt BPAuS could only do some of the tasks and when it failed there were a lot of work required to solve issues.

When BPAuS worked, it met expectations, with Catalogue.Manager1 saying "*when it works it does a good job and … was great*".   All the workers felt that when BPAuS worked, it performed as expected.

In a separate supporting document provided by the manager, a review of the time spent to perform the task by the workers before automation was 1,040 hours per annum and after automation was 0 hours per annum, identifying a saving of 1,040 hours (0.58 FTE staff). The findings do not align with the views on level of automation delivered and with the commentary. The position was rec-confirmed by the manager, noting that the task automated accounted for 19% of the workers job (see Table 6).

5.3 Case Study 3: Appointment (New Appointment Form)

5.3.1 Automation Build: Appointment

In June 2019, the development team provided the Appointment Team with a checklist of activities they needed to complete before the automation development could commence.

This included ensuring there were a complete set of detailed process maps, procedures and work instructions for the development team to refer to when building BPAuS.

Early into the review it was identified that a significant amount of work was necessary by the Appointment Team to review and update all their documentation. Where documentation did exist, this was not to the level of detail required, for instance it did not capture every keystroke or fully describe the actions expected by the system. These were critical pieces of information required for the automation. The timescales for this work would run into several months because of existing work commitments. There was recognition by Appointment.Manager1 that getting the documentation completed entailed a considerable amount of work but was necessary: *"we had to set expectation how quickly we could deploy a robot"* (Appointment.Manager1).

Any delays in completing the documentation would impact on the timescales. BPAuS build was an iterative process between the development team and Appointment Team to validate that the automation was performing as expected and could handle all the different scenario of data and conditions that may arise. Appointment.Worker1 commented:

> *"I had to spend a considerable amount of time checking each and every step of the robots to ensure it was doing what was expected"*

This process provided the team with confidence that when BPAuS was finally deployed it would work; *"Watching the robot take care of different situation provided us with confidence that when it was ready for final deployment"* (Appointment.Manager1)

Appointment.Worker1 said that they did not encounter any significant issues with the automation during the testing and build process and this provided further confidence that the go-live would be successful. The go-live was planned for 14th Oct 2019, however, this was delayed due to factors outside the Appointment Team control. Suppliers updating some reports in their Recruitment system would stop BPAuS from working correctly. A workaround was programmed into BPAuS to ignore the report changes to overcome this issue. The time taken to fully deploy the technology was 3 months.

5.3.2 Automation Implementation: Appointment

The post-automation interviews were conducted six months after the initial go-live deployment 27th Oct 2019. Despite all the testing and checks, Appointment.Manager1 reported that BPAuS worked well for only a week and then started to malfunction. There were various issues, for instance, BPAuS was performing tasks faster than the Recruitment system was able to process the data. In other cases, BPAuS was not correctly identifying the entry fields needed to populate data and started to perform tasks that were not correct for the process. This resulted in the automation failing to process the majority of the records. Appointment.Worker1 explained:

> *"it was a strange feeling…. . I noticed it wasn't doing this correctly, saying to myself, 'hang on, I don't do that' and made a note of this."*

The development team recommended to Appointment.Manager1 not to stop BPAuS whilst investigating what was going wrong, leaving the workers to manually correct any issues identified. Appointment.Worker1 and the developers spent three days working out what was going wrong with BPAuS. It was eventually identified that BPAuS was built to access the Recruitment system using Microsoft Internet Explorer browser, whereas the Appointment Team used Google Chrome. The difference in browsers had an impact on the speed the Recruitment system responded to actions and the quality of the entry fields being identified. When BPAuS was amended to run using Google Chrome browser instead, all issues disappeared. It was mid December 2019 before the department resolved the issues with the automation.

Appointment.Worker1 said that there has been no change to their role or qualifications needed. The automation had allowed the workers to spend more time performing tasks that they had previously postponed, for instance validating the application form and dealing with telephone calls. Automation had resulted in some new duties being created. A new task was created to check the automation every morning to ensure it worked before the workers moved onto other activities. At the end of the day the workers also check control reports to ensure the automation has completed its tasks successfully. Where the automation failed to perform tasks because of issues, for instance with the data, then the workers had to manually correct the data. Although the workers did not perceive they had gained new skills, what was observed was that the workers gained trouble shooting skills. These skills related to identifying what had gone wrong with the automation and how to fix the issues. The time taken to fix the issues varied from a few minutes to sometimes several hours. When the reason for the issue could not be easily identified then the development team were contacted to see if they could resolve the issue. Appointment.Worker1, saying *“this gives me a new type of challenge to deal with”*.

Appointment.Manager1 did not feel the automation had changed their role, however, it had created capacity for the worker to get involved in additional activities, for instance answering telephone calls and carrying out additional checks and controls on documents received.

When the interviewees were asked what level of automation was actually delivered compared to what they expected, Appointment.Manager1 stated level four (up to 99.9% performed by automation); this was higher than the expected level three (up to 75% performed by automation). The reason given for this was because when BPAuS works, it performed the task expected (i.e. completing the form) accurately, however, there was recognition that it could not handle every situation because of the quality of data received. This still required workers to sort out the issues that Appointment.Manager1 had assumed would not arise. Appointment.Worker1 agreed on level four automation which was in line with their expectations. Appointment.Worker1 said that when the automation worked, it worked well, remarking:

> *“I can beat the robot downloading reports [from the recruitment system] but I can't beat it inputting information into a form.”*

Appointment.Manager1 believed the automation would save a significant portion of the workers’ time and save the department from having to recruit additional staff to handle the volume of work for the five additional health boards.

> “*Just to be clear we are not looking to lose staff, we are simply trying to make full use of existing resources to handle ongoing demands placed on the department*” (Appointment.Manager1)

However this view was not supported by Appointment.Worker1. Appointment.Worker1 indicated that most of the workers’ time was spent answering phone calls, dealing with queries, and correcting data people had entered on the form. Appointment.Worker1 could not say what proportion of this time was automated, although estimated this to be between two and four hours per week and not the twelve hours the manager indicated and there were still two workers assigned to support the automation.

A review of the time spent by workers to perform the task before automation was 960 hours per annum and the time spent after automation was 756 hours per annum, identifying that the automation had delivered 240 hours (0.11 FTE staff) savings for the team. This reflects the information provided by the managers and does not take into account what Appointment.Worker1 reports.

5.4 Case Study 4: Roster (Roster Shift Pattern Payment)

5.4.1 Automation Build: Roster

The development team liaised with the Rostering Team in January 2018 to understand their existing processes and what documentation existed detailing the activities performed. Few work instruction documents were available and no process maps existed. The development team created the missing documentation. Separately, documentation was produced that detailed the different events of what could go wrong with the process and what needed to happen in each case. This was important to ensure the correct logic was built into BPAuS.

The manager said producing the documentation was a time-consuming exercise, taking at least seven days, however, they recognised this was essential to help the development team build the automation. Preparing the documentation required a lot of time commitment from the workers, working with the development team. This became a big challenge for the workers given the pressures they were under to manage the rostering shifts.

> *“We ended up working additional hours to help the development team as we were informed it was to make life easier for us in the longer term.”* (Roster.Worker1)

Once the documents were prepared for each task, they were shared with the Rostering Team and Roster.Manager1 was requested to confirm the documents and to sign off the documentation. The BPAuS build was an interactive exercise between the development team, Rostering Team, Accounts Payable and Finance departments. Collectively the decision was taken for BPAuS to access the Rostering system directly and use the information from that system to update the Finance system. Four specific tasks in the Finance process were agreed to be automated with the Rostering Team: the creation of the order to the agency, the receipting of the order once the shift had been worked, cancelling the order if the shift was not worked, and adjusting the order if different hours were worked. Each of these tasks was individually built, tested, reviewed by the Rostering Team manager, signed off and then deployed before the next task was built.

The build process identified the need to have some mechanism to share the results from BPAuS with the Rostering Team so that they could identify the transactions that had been processed and which ones required manual intervention. A shared network folder was created that could be accessed by both the Rostering Team and the automation. The folder stored a log of the status of the activities performed by the automation.

It was agreed by the manager and the development team that BPAuS would be set up to work with two agencies initially as a proof-of-concept exercise. This was designed to provide assurances to Rostering Team staff that BPAuS could perform the required tasks. The agencies chosen reflected companies that usually provided accurate information in the correct format to Rostering Team. The proof-of-concept went live in July 2018. After a number of months assessing the automation activities, several challenges emerged. These included ensuring the date entered in the Rostering system was consistent for every agency, completing the same fields in the same way, including dates in the format dd/mm/yyyy. All of this was necessary for BPAuS to find specific data and to ensure that the correct entries could be created in the Finance system. The correct shift rates also had to be captured. Roster.Manager1 remarked:

> "*The robot was only good as the data we held… therefore we had to ensure it was correct.*"

There were some technical issues with the machine BPAuS was controlling. One of these was the operating system feature that locks the PC if there is no activity detected for a period of time; when the PC locked, the automation failed. This was resolved by disabling the PC lock feature.

The proof-of-concept lasted over 12 months until all key issues were resolved and the Rostering Team workers and manager were satisfied that BPAuS was working as expected. During this period as the workers could see the benefit the automation was providing by reducing the need for them to update the Finance system and as fewer issues were reported by the agency, their confidence in BPAuS grew and they looked forward to BPAuS working with the remaining agencies. Roster.Worker1 commented:

> *"I soon felt reassured that it was working and actually working much better than I expected. It was great to see and I couldn't wait for the robot to start processing records for more agencies."*

At this point, Roster.Manager1 agreed for BPAuS to proceed with processing the activities from a further 19 agencies. These additional agencies went live in November 2018. In total about 1,700 shifts were being processed by BPAuS. There still remained 10 agencies that Roster.Manager1 wanted the Rostering Team workers to manually process. This accounted for about 100 shifts. The reason for not passing these to BPAuS was because of data issues experienced with these agencies. Until the agencies were able to send correct and accurate information in the required format every time, Roster.Manager1 felt it would create too many problems for the automation and in turn increase the workload for Rostering Team. The time taken to resolve issues to fully deploy the technology was 12 months.

5.4.2 Automation Implementation: Roster

The post-automation research took place about three months after BPAuS went live with 21 agencies. When asked what activities still took place to support the automation, the workers said they occasionally have problems with BPAuS not being able to process about 100 records per week. These are passed to the workers to investigate, correct the issue and then pass the record back to BPAuS to process again. The workers said these problems were part of the learning curve to evolve and adjust BPAuS logic so that it could correctly identify and improve how to process the records that were failing. When asked what they would do if BPAuS stopped working, Roster.Worker1 said they would be "*mortified*" and "*could not now do without the robot helping them*".

Changes to the nature of the job, skills and work characteristics could be observed. With BPAuS performing most of the routine tasks and updating the Finance system, the workers' job had changed. The level of routine data entry work has reduced significantly. The workers were now spending more time checking agency timesheets to ensure the accuracy of payments and spending more time working with hospital wards to understand staff shortages and need for agency workers. The knowledge and skills needed in updating the

Finance system was expected to be lost over time because of the automation. There were new skills being gained by the workers to problem solve issues with BPAuS when it stopped working and to try and fix the issue or manually complete the task. Where the issue with the automation could not be resolved by the workers then the BPAuS development team were contacted to problem solve the issue.

All interviewees felt the level of automation delivered was in line with expectation at level three (up to 75% performed by automation), with Roster.Manager1 saying:

> "*We are totally reliant on the robot. We are not sure what we would do anymore without the robot.*"

The level of automation reflected what the workers were still manually processing. Roster.Manager1 commented that when all agencies are eventually managed by BPAuS then their expectation is for the level of automation to increase to level four (up to 99.9% performed by automation). The workers did not expect to achieve full automation because shifts still needed to be manually verified with the ward. Someone would need to deal with the issues reported by BPAuS which they felt would still occur because some agencies would continue to send incorrect or incomplete data.

When Roster.Manager1 was asked what the changes had meant to them, the response was positive. Once the initial issues identified from the proof-of-concept had been addressed and the automation was processing the records for the majority of agencies, benefits had been seen. The automation processing the Finance system records with minimum intervention from a worker meant that fewer workers were required to manage the workload for the Rostering Team. The two permanent workers remained in the department, their time was now spent performing duties they previously never had time to complete, for instance validating the request forms and checking what shifts had been worked. The temporary agency worker that was brought in to help the department workload was no longer required and their employment was not extended. Although this was a job lost, the manager did not view it as a job lost because of the temporary nature of the worker's role. That said, there was a direct saving for the department on the money spent on temporary workers. Roster.Manager1 remarked:

> "*The benefits to me have been enormous…. now I can reduce it to one member of staff doing it [the data entry] 3 days per week…previously I had 3 full time staff doing it for two full weeks every month pretty much every day*."

Another positive outcome reported by the manager was that the Rostering Team no longer appoint a new agency supplier to work with the health organisation until the supplier can confirm they can provide information in the format that allows the documents to work with the automation without the need for any worker intervention. This reduced the need for the department to have to process the files manually. The Rostering Team now process 76% of invoices on time (up from 27%) and this rate is increasing. Roster.Worker1 commented that "*they love it [the robot], the benefits are fantastic*" as it has reduced the pressure on them and improved staff morale by reducing the demand pressures faced by the department. Additional benefits have included fewer issues for the Accounts Payable and Finance departments to deal with.

The manager said the time saved allows the Rostering Team to provide a better service to agencies and the health organisation. Rostering Team were considering working with more agencies to support the filling of shift covers and felt more comfortable working with more agencies knowing that the workers had more time now to focus on value-added activities. The workers spend more time verifying shifts, ensuring timesheets and invoices match and work with the wards to verify the shifts and enter these on the web site. This in turn results in fewer mistakes and issues arising when invoice payment is made.

Roster.Manager1 was keen to extend the automation into other areas of the organisation to assist the Rostering Team, for instance to take the shift bookings from the web site and enter these into the Rostering system.

A review of the time spent to perform the task by the workers before automation was 6,573 hours per annum and after automation was 1,997 hours per annum), identified that the automation had delivered 4,576 hours (2.5 FTE staff) savings for the team. The savings reflect the automation performing most of the activities necessary in the Finance system.

5.5 Case Study 5: Contract (New Staff Contract)

5.5.1 Automation Build: Contract

Contract.Manager1 stated that when they started to review their processes for carrying out pre-employment checks and issue contracts to new staff in February 2019, they identified gaps in their process documentation. Most of the standard operating procedures were high level and did not describe in any detail what had to happen in every decision-making scenario. A great deal of the judgement about steps to be taken when the process could not be completed was left to the workers and where necessary for them to seek guidance from their managers.

Over a period of at least three weeks, the workers and managers collectively spent time reviewing and updating all the process documentation making it as comprehensive as possible. Contract.Manager1 said that three weeks was not enough time to determine all the scenarios and therefore had to allocate another three weeks to complete this work.

5.5.2 Automation in Abeyance: Contract

The automation was not implemented. The Onboarding Team made the decision in August 2019 to delay any immediate plans to automate the task to create new staff contracts. The managers had expected the automation to have some intelligence and be simpler to implement than was the situation. Until the project started, the managers had not fully appreciated the need to identify and document every scenario of the process, including what could potentially go wrong and what had to happen in each of these situations. The team felt more time was required to fully consider all the risks and impact of delivering the automation.

The decision followed the Onboarding Team review of their existing processes identifying unnecessary tasks and updating documentation to ensure it was detailed enough to prepare for automation. The team spent time considering the impact of the automation on how they would conduct work in the future, in particular, if the workers were released to undertake new roles. The concern related to the Recruitment system and Payroll system that would be used by BPAuS. These systems are delivered and supported by third party suppliers and can sometimes be updated with new features and functionality with little advance notice to the team. This could mean if screens or processes changed, then there would be a lead time to get the BPAuS programme updated to work with the new changes. Contract.Manager1 put it like this:

> "*If we cannot receive a clear schedule of what is going to change in these applications… then there is a risk the robot could fail and we wouldn't have the time to update the robot*"

The managers felt they needed certainty that there were clearly defined processes in place in the event the automation failed. This was because of the legal requirement to issue contracts and requirements to comply with tax and national insurance legislations. In the event that BPAuS failed, it was not clear to the managers which worker could support the automation to ensure it still worked and to fixe any issues quickly. Contract.Manager1 commenting:

> *"more worrying are the new workers joining the team in the future, they would not have any previous experience to step in [if the automation failed]"*

Understanding whether any worker would be expected to retain relevant knowledge of the process to manually perform the task in the event BPAuS stopped working remained unclear. This included which workers would still be expected to have knowledge to understand the full impact of application updates on existing processes.

The risk was that unless these considerations were fully mitigated it could impact on the team's ability to prepare and issue employment contracts to new staff. Failure to issue contracts could result in reputational damage for the organisation and having to pay compensation to potential employees. Onboarding Team felt it was too high risk at that time to automate this activity without fully understanding and preparing very detailed and relevant contingency arrangements if things went wrong with BPAuS. Contract.Manager1 explained:

> *"we started to rethink our approach when we explored what all of this could mean... we felt this added a level of complexity and risk for the business … not something we had thought about when we first considered automation."*

The manager said that it may be that the final outcome is not to progress with the automation as the risk to the organisation may not be justified albeit the task was routine, repetitive and boring. Contract.Manager1 also reported that managers in their department were saying: *"if [the current process] it's not broken then what are we trying to fix?"*

Reflecting back on the journey to-date, Contract.Manager1 felt that nothing would have been done differently regarding the decision taken. Exploring the potential to automate the task was the catalyst to reviewing their processes, to ensure it was lean and documentation was up to date. The exercise had made them question the real impact on the team and risk to the organisation if the workers moved onto other jobs at a future point.

5.6 Case Study 6: Payroll (Hire Applicant Process)

5.6.1 Automation Build: Payroll

The IT department worked with Payroll Team in December 2019 to review the existing documentation to determine whether they contained all the information required to allow the IT department to build BPAuS. The review identified that there were considerable gaps in the documentation, in particular pertaining to the scenarios of what could go wrong and how each of these situations needed to be addressed. Payroll.Manager1 said this identified a considerable amount of work needed to be undertaken before the IT department would look to build the automation. During the review it also made them question what steps they were following:

> "*we realised that there was an opportunity for us to question why we do certain tasks and if there was an easier way of doing some of these activities to improve our processes*" (Payroll.Manager1)

Payroll.Manager1 felt more time was required to complete their review before considering whether to move forward with the automation.

5.6.2 Automation in Abeyance: Payroll

The automation of the payroll process was not implemented. Payroll Team made the decision in March 2020 to delay any plans to automate the task when they realised that there was an opportunity for the team to question their existing processes and identify whether any activities could be streamlined or simplified in any way. This included a review of the data entered in the Payroll system and whether more checks and controls were needed earlier in the process by the Recruitment Teams when appointing new staff.

This would reduce the need for checks and data entry by the Payroll Team. The approach would reduce any potential duplication of checks and controls across multiple departments and teams. Separately, Payroll Team wanted to fully consider the impact of the functionality changes and the frequency of the updates made to the applications delivered by third party suppliers. This was to understand what this would mean to the department, to BPAuS and the concerns raised by workers that they felt they would lose knowledge of the process to assess the impact of Payroll system changes on internal processes.

As a consequence, the Payroll Team wanted to delay plans to automate the task. Payroll.Manager1 said it was not about automation but to allow them to carefully review every step of what they presently do. Reflecting back on the journey to-date, Payroll.Manager1 felt that nothing would have been done differently regarding the journey and the decision taken. The plans to consider automation was the "trigger" for Payroll Team to review their processes. Payroll.Manager1 was considering automation at some future point:

> *"We have not made a final decision on whether we will proceed with the automation. This decision will be taken at some point but I cannot say exactly when."*

5.7 Cross Site Summary

Four sites implemented BPAuS technology (case studies 1 to 4) albeit they experienced a number of challenges on their journey, and two sites (Contract and Payroll) moved their plans to automate into abeyance.

The findings indicate that there are four key factors influencing the deployment of BPAuS. One of the factors is the quality of existing process documentation. In all the cases it was found that without detailed documentation, including a record of all keystrokes performed, it is difficult for the IT department to design and build BPAuS. The information particularly important in the documentation is details describing all the scenarios of what could go wrong and how each of these situations must be addressed. Capturing this level of information was a time consuming exercise and sometimes ran into several months. The exercise required considerable resource commitment from managers and workers alongside their existing work commitments. This was not viewed as the reason why the Contract and Payroll sites did not go ahead with the automation.

A second factor is the quality of the data to be processed by the automation. At the four sites where BPAuS technology was implemented, managers and workers identified that it was important for the data to be accurate and any data issues had to be corrected by the workers beforehand. A recurring issue across the cases was that dates needed to be in the correct format dd/mm/yyyy for the BPAuS technology to correctly work. If this was not done then automation would be less reliable and less accurate and in some cases would stop working, requiring a worker to problem-solve the issue. The time taken to fix issues varied from a few minutes to sometimes several hours. When workers could not resolve the issues then the BPAuS development team was contacted for assistance.

A third factor is the complexity of the process to be automated and complexity of the data to be used. In the four sites that deployed BPAuS technology, the processes presented for automation were simple, required little judgement to be made, the tasks decision pathways was simple to define and all the data needed to perform the process was held in digital form, whether in spreadsheets, databases or in software applications. Observed at the Contract site and Payroll site was that the complexity of the task and data (i.e. creating employment contracts). This depended on the nature of the data to be processed (i.e. the type of contract to be created, for instance tailored contracts for specialist jobs or more routine contracts for all other jobs). Therefore, even where a task is chosen for automation, if the data is not simple, routine and straightforward to process then this may determine to what extent the task is automated.

A fourth factor that emerged was that risks could impede implementation. Tasks at the Contract and Payroll sites (where the automation moved into abeyance) were critical in nature and presented risks to the organisation if the process was not performed when required. The risks included the legal requirements to prepare contracts, reputational damage and having to pay compensation if employment contracts were not issued in a timely manner or staff were not paid appropriately. These critical operational risks did not exist at the four sites that implemented BPAuS and therefore the four sites were lower risk. The Onboarding Team felt it was too high risk at the present time to automate this activity without fully understanding the full consequences if the automation failed. This required detailed consideration to ensure the automation could not fail or relevant contingency arrangements were in place if things went wrong with the automation outside the Contract team control, for instance if the team was not made aware of a change to the software application used by the automation, Contract.Manager1, explained. A further risk that needed to be managed across all sites was the impact of software application changes used by BPAuS and whether the changes impacted on processes.

Reviewing the time taken from commencing the automation project to when the automation was fully implemented (see Figure 15; black to yellow dot) highlights that there was a large amount of effort required to prepare for the automation and then build BPAuS. This activity often took longer than originally planned, requiring between three months and twelve months, with the longest period observed in the Roster case. There were three common reasons for the project duration. Firstly, the time taken to update existing process documentation. Completing the document varied at each site, for instance at Appointment site this took several months to complete because of existing work commitments. Secondly, the time taken to build BPAuS, which varied depending on the complexity of the process to be automated and the number of scenarios that had to be programmed into BPAuS. The build typically took between one and two months. Thirdly, the time taken to fully test BPAuS to ensure it worked as expected across all scenarios and to address all data quality issues found during testing. The time taken to complete the testing varied, and is represented in Figure 15 by the yellow to green dots, took from 3 to 12 months.

Table 7 sets out a comparison of the changes identified to the structure of work across all the sites. At the four sites that implemented automation, a new task was created to monitor the automation and a new basic level of skill needed to problem solve any issues with BPAuS. The nature of the problems to be fixed with the automation would be different at each site because of the nature of the process the automation was performing. These unplanned duties and new skills did not result in any review of the qualifications required to perform the job and did not have any significant impact on the nature of the job or skills required. The time saved by workers was spent performing other aspects of their role that they previously did not have time to perform. Some of the time saved was spent early in the process to review the quality of the data for the automation to use. Despite the additional task and shift in balance of work, there were projected net time savings for workers across the sites. The greatest savings was at the Roster site that estimated over 4,500 hours per annum of the workers' time would be saved. The workers were still expected to spend almost 2,000 hours per annum supporting the activities not performed by BPAuS. The Appointment site expected to make the least amount of saving estimated at 204 hours per annum, with workers still expected to spend 756 hours per annum on the activities not performed by the automation. Once BPAuS bedded down managers and workers expected that the time savings for workers will further increase.

At the Statement, Catalogue, Appointment site and Rostering site, the workers did not view BPAuS as a threat to their job and they were enjoying their roles more because their activities moved away from having to prioritise the routine and repetitive tasks to performing other tasks and duties within their job role. However, at the Rostering site, where the entire job was put forward for automation (see Table 6) job loss was observed. There was also some concern that workers would lose the knowledge and skills to perform the Finance aspects of the process. The variation in job loss that arose across the four sites relates to the percentage of the job actually automated, which in most cases was only a subset of the entire job.

The findings highlighted the need for the three stages of the adapted Parasuraman et al. (2000) framework (see Figure 16) to be updated in light of the research. Exploring task receptive to automation stage (see Table 1) identified that three additional criteria's are required to identify tasks suitable for BPAuS technology. Against the analysis of information class of function, a criteria is required to assess the complexity and quality of the data to be used by the software agent. Against the implementation of action class, two criteria's are required. First, to assess the risk to the organisation if the automation failed and workers could not successfully step in to intervene and fix the automation or manually complete the task. Second, to assess the frequency and extent of changes to the software applications the automation interacts with and the extent the automation will need to continue to be updated. The two last criteria's were evident at the two sites (Contract and Payroll) that moved their automation into abeyance. A review of the level of automation (LoA) stage, identified a new LoA model was required to simplify the assessment of the extent a task was automated compared to being performed manually. Using the new model, highlighted that there were mixed views on the level of automation expected (see Table 9) at the sites and what was actually implemented (see Table 10) across the six sites by managers and workers. At two sites (Appointment and Roster), the LoA delivered was generally in line with what they expected. At two sites (Statement, Catalogue) the actual level of automation delivered was reported to be less than had been expected. For example, Catalogue.Worker3 expected the LoA to be three, however stated what was delivered was LoA one. This reflects the issues the worker had with making the automation work and the ongoing need to support the automation when it goes wrong. The lower LoA being stated may be because during the initial implementation of the automation most of the sites experienced issues with getting the automation to consistently work and had to support the automation when it failed. Many of the workers did indicate that if there was less need to fix the automation then they would expect the LoA stated to be higher.

The benefit to the organisation was not just staff time savings, it includes improved quality of service provided to customers and suppliers. There are savings to be realised from prompt payment and recovering credits due from suppliers. Reviewing the existing process documentation also provided opportunities for teams to review and improve existing processes. The savings and benefits provided by the sites have not factored in the ongoing cost of the technology and the implementation effort. This is because the IT departments at the two organisations did not want their costs to be factored in since they are funded centrally by the organisation to work with departments and team to implement technologies. The cost of one BPAuS technology license is about £10,000 per annum. Only two BPAuS licenses were required to handle the volume of work across the four sites that implemented the technology. The IT departments mentioned the two BPAuS were only operating at 60% capacity. The cost of the two licenses are absorbed by the IT departments at the two organisations.

Figure 15 – BPAuS technology project timelines

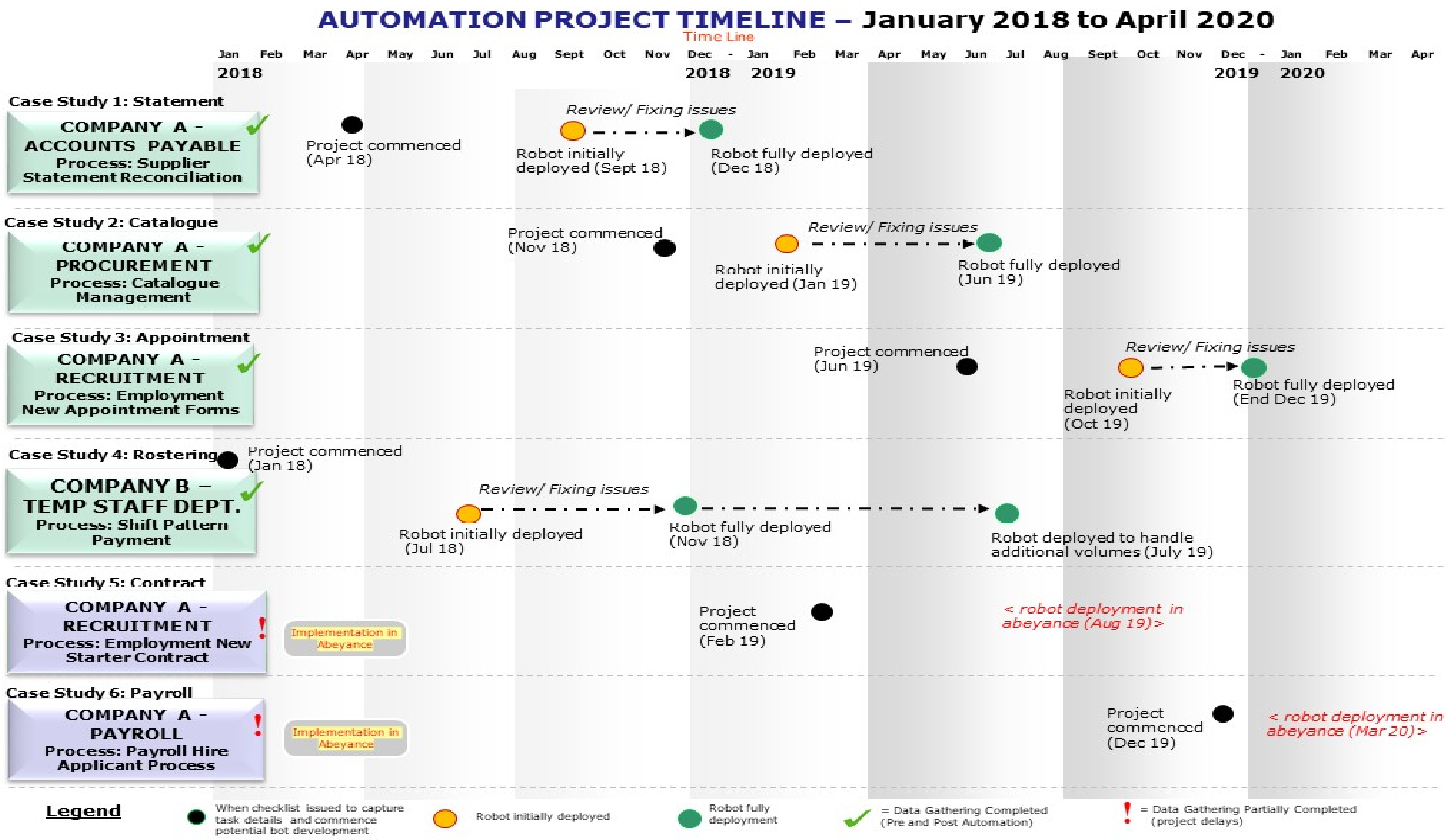


Figure 16 – Adapted three stages to automation task design

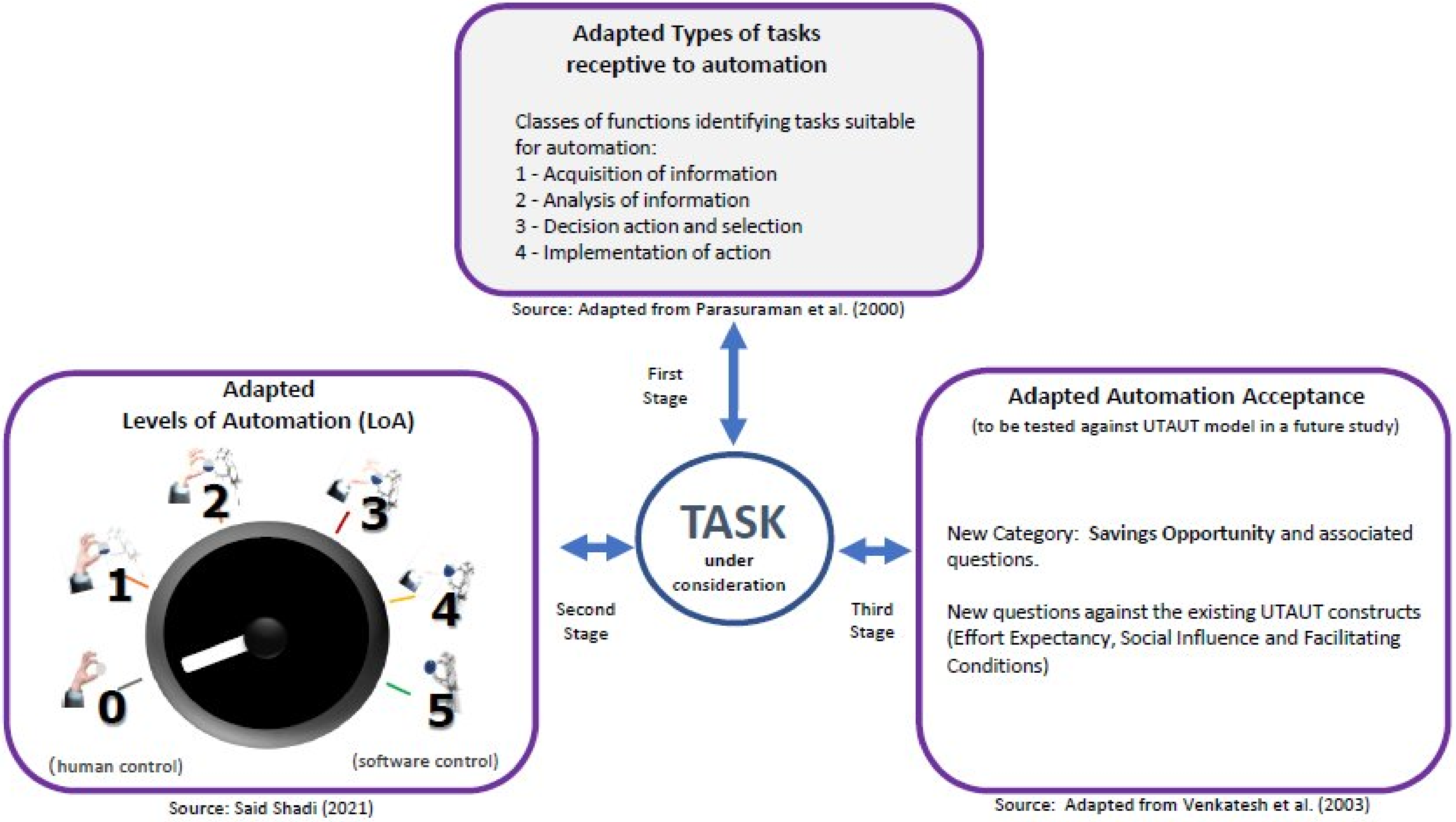


Table 7 – Post-automation summary findings across the case study sites

Structure of work changes	**Automation successfully implemented**				**Automation in abeyance**	
	Site 1: Statement	**Site 2: Catalogue**	**Site 3: Appointment**	**Site 4: Rostering**	**Site 5: Contract**	**Site 6: Payroll**
Job Characteristics (task variety, responsibilities and job demands)	• New responsibility to monitor BPAuS • Rebalance of work, more time early in process to address data quality issues; no additional pay considered				No change –opportunity to review existing processes	
	Only a subset of the job automated. Job loss arising from not having to recruit temporary workers			Job loss reported		
Skills Characteristics (job complexity, qualifications, skills)	• No impact on qualifications, wages or job grade • Workers concerns regarding retaining knowledge of process • New skills created to fix problems with the automation				Workers' concern regarding lack of future knowledge to perform task if automation failed	
				Skills being lost		
Work Characteristics (challenges, resources, output and outcomes)	• BPAuS more accurate and faster to complete tasks than workers • More time to spend on other job activities • Increased staff morale , less pressure on workers • Reliance on BPAuS working				• Organisation risk if the automation failed • Workers' concern to take over if automation stopped working	
			Improve staff job satisfaction			
Savings Opportunity (net time saved per annum by workers)	770 hours	1,040 hours	204 hours	4,576 hours	NA	NA
Level of Automation (expected/delivered) (Mode statistical analysis method - across all responses) * See note	Expected: 3 Delivered:2,3	Expected: 4 Delivered: 2,3	Expected: 4 Delivered: 4	Expected: 3 Delivered: 3,4	Expected: 2,3 Delivered: NA	Expected: 3 Delivered: NA
Time taken to test/deploy BPAuS	4 months	6 months	3 months	12 months	NA	NA
Additional Information	• More detailed work instructions required – every keystroke recorded • Considerable workers effort to prepare process maps for all scenarios, including failure points and to support the build of BPAuS • At implementation, considerable effort required to address data quality issues • Delays and issues with BPAuS outside the teams control				• More detailed work instructions required – every keystroke • Considerable effort to prepare process maps for all scenarios • Risk to automate too great for the department	

* Note: *LoA:2 – Partial automation (up to 50%); LoA:3 - Conditional Automation (up to 75%) and LoA:4 – High automation (up to 99.9%), NA - not applicable*

5.8 Conclusion

This chapter presents the post-automation stage, examining the first research question that sets out to explore the main factors to consider when implementing BPAuS technology. The findings highlighted that sufficient time should be allocated to prepare for BPAuS implementation since this was underestimated at every site. Even where a task is identified as a suitable candidate for automation based on the routine and repetitive nature of the activity, it does not mean these are the only considerations. At all the sites, the quality of the data and whether detailed documentation existed were important considerations.

A further consideration identified at sites 5 and 6 was the complexity of the process and the risk to the organisation if the automation failed and workers could not step in to manually perform the task. The findings present a revised five level of automation model (see Figure 9) that can be used to assess the extent of human involvement in BPAuS technology. Based on this model, the findings provide an initial indication that there is a need for human workers to support the automation to complete the process activities.

The findings highlight that at the four sites that deployed BPAuS, there was implications on job characteristics, with workers taking on new responsibilities to solve issues when the automation fails. There was implication on work characteristics with a shift of the balance of work and workers having more time to perform other activities within their job role that they previously did not have time to perform. There was also implications on skills, with the workers gaining skills to fix issues with the automation when it failed. Separately, the findings highlight that when departments have peak demands in workload and previously required the recruitment of additional labour, mainly temporary workers to undertake specific tasks, then these workers had been replaced by automation. In all cases, only specific tasks that were routine and repetitive were automated and not the entire business process. However, at two sites (Contract and Payroll) the automation was further limited to specific types of records and not the entire task. This was because certain types of records required judgement to be made. These findings highlight many similarities with other forms of automated technologies.

Chapter Six: Case Study Findings III – UTAUT Model Assessment

The chapter explores the third research question. The objective was not to empirically test the Unified Theory of Acceptance and Use of Technology (UTAUT) model, instead it was to explore whether the model captures the key categories to consider workers' intention to use BPAuS technology. Assessing UTAUT is the third stage of the automation task design framework (see Figure 16).

The chapter reviews the suitability of the existing categories by exploring the responses to the statements used to assess BPAuS technology (see Table 8) and from reviewing the findings presented in chapter five (post-automation). Section 6.1 reviews the questions applied to UTAUT, this is followed by a review of the existing four categories (Sections 6.2 to 6.5), with section 6.6 describing the new category required to support BPAuS technology. Section 6.7 provides concluding remarks about the model.

6.1 Review of Questions applied to UTAUT

Table 8 shows the questions asked to participants in exploring the suitability of the existing categories of the UTAUT model when applied to BPAuS technology. The review was not about testing the suitability of the statements because of the small sample size and nature of the research question. The original question statements used by Venkatesh et al. (2003) to assess the UTAUT model against a broad range of technologies was used, with the wording carefully modified to fit the BPAuS technology context. Table 8 reports the Likert value range and mode of workers' responses. Appendix G provides participants' detailed responses against the questions, including any commentary given to explain their selection. Although the questionnaire was issued to managers and workers, only workers completed all of the questions, with managers only responding to specific questions (questions 14 to 23). This was because the managers felt that some of the statements were more relevant to the workers that worked with BPAuS.

Table 8 –UTAUT questions Likert value (Adapted Venkatesh et al., 2003)

UTAUT Category	#	Questionnaire Statement	Likert Value (Range) * see note	Likert Value (Mode) * see note
Performance Expectancy	1	The automation is useful in my job	**3 to 5**	**5**
	2	The automation allows me to do my job more quickly than before	**3 to 4**	**3**
	3	The automation has helped to do my job more accurately than before	**2 to 3**	**2**
	4	The automation has allowed me to save time to focus on other duties	**2 to 5**	**4**
	5	The automation provides me with accurate and consistent information every time	**1 to 5**	**4**
	6	The automation has allowed me to make better use of my skills	**2 to 4**	**4**
	7	I am comfortable working with the automation	**3 to 5**	**5**
	8	I have to always use the automation to undertake the process/task	**3 to 5**	**3**
	9	I can look for new opportunities in the organisation because the process/task is now performed by the automation	**2 to 3**	**3**
Effort Expectancy	10	Learning what I could do with the automation was easy for me	**3 to 5**	**3**
	11	Interacting with the automation is easy	**3 to 4**	**3**
	12	Setting up the automation to correctly undertake the process/task was easy	**2 to 3**	**3**
	13	Using the automation takes too much time and effort away from performing my normal duties	**1 to 3**	**2**
Social Influence	14	I trust the automation to complete its activities correctly every time	**2 to 4**	**3**
	15	I trust the automation to tell me when it is having issues in completing the process / task	**3 to 5**	**3**
	16	I have the necessary resources (training, procedure, guidance) to enable me to understand and work with the automation	**3 to 5**	**5**
	17	A specific person is available to provide me with assistance when there are difficulties with the automation	**3 to 5**	**5**
Facilitating Conditions	18	I know who to contact if the automation stopped working or if I noticed an issue	**3 to 5**	**5**
	19	I am confident someone in my department will know if the automation is not completing its tasks correctly	**3 to 5**	**4**
	20	If the automation stopped working and could not continue then we still have the resources in the team to perform the process/task manually	**3 to 5**	**3**
	21	If the automation stopped working and could not continue then we still have the knowledge and skills to perform the process/task manually	**3 to 5**	**5**
	22	My job role has changed because of the tasks now performed by the automation	**2 to 4**	**3**
	23	My skills have changed because of the tasks now performed by the automation	**2 to 4**	**4**

Note: * 5 Point Likert Scale:
1 =Strongly Disagree; 2=Disagree; 3=neither Agree nor Disagree; 4=Agree; 5=Strongly Agree

The range was used to explore the measure of spread of participant responses against each statement. The range was useful to assess the extent of variability for each statement to explore the usefulness of the measure. The mode was used to explore the most frequent value chosen across the spread. The higher the Likert value chosen the stronger the statement on the usefulness of the technology. The nature of the data meant that it was not relevant to use the mean or medium measure of tendency.

The variability of participant responses against each question suggests the usefulness of the measure. From reviewing the data, the existing categories look relevant. The participants' comments against each question and the review of the findings for the four case studies that implemented BPAuS (chapter five), highlight that to consider all aspects of BPAuS, a number of new questions need to be asked. In addition to the existing categories, a new category is also necessary. The new questions and additional constructs are explained further in the remaining sections.

6.2 Category: Performance Expectancy

Questions related to performance expectancy seek to understand whether the technology enhances a person's ability and productivity to perform an activity. The variability in responses (range of mode) against the category performance expectancy, suggests that there are different views on the performance of BPAuS to assist workers. For instance, to question one "The automation is useful in my job", most participants strongly agreed with this statement, with Catalogue.Worker2 stating that the automation has "*taken over the more mundane tasks*", and Roster.Manager1 commenting they are doing "*less firefighting and more time doing what I am meant to do*" (see Appendix G for participants comment). To question three "the automation has helped to do my job more accurately than before", most participants did not agreed with this statements. This may be because of the shift in the balance of work, with the workers spending more time early in the process to cleanse the data for BPAuS to use.

The findings did not highlight the need for any additional questions against this category to further the understanding of workers' performance in the context of BPAuS technology.

6.3 Category: Effort Expectancy

Effort expectancy is about the effort required to learn, setup and use the technology. Whilst participants did not agree that setting up the automation was easy (question 12), for instance Appointment.Worker1 commenting:

> *"I had to spend a considerable amount of time checking each and every step of the robots to ensure it was doing what was expected"*

The participants also did not agree that using the automation takes too much time and effort away from performing normal duties (question 13). This suggests that following the effort to setup the automation, it will be helpful to the worker.

A review of the four statements (questions 10 to 13) against the category highlight that they do not capture specific nuances that can arise with using the technology that may impact on effort. For instance, the findings reported in chapter four highlight three additional categories of questions. Firstly, questions on the level of automation implemented. This is to explore the extent the technology performs all aspects of the task and whether there would still be some effort required for the worker to support the automation. This was relevant at the four case sites where the automation was implemented (see Table 7). Secondly, questions on the effort to setup and modify the automation. This is to explore the perceived work effort involved in setting up the automation, to ensure any missing or incomplete documentation is available. This includes the effort to amend the automation because the process changes or the application used to run the BPAuS technology changes, requiring modifications to the automation. This situation was identified at the two sites (Contract and Payroll) where the automation moved into abeyance (see Table 7). One of the reasons provided for delaying their implementation was the concerns they had in not being able to fix the automation in a timely manner if it failed and the impact this would have in performing their activities to meet legal obligations. Thirdly, questions on any additional duties created. This is to explore whether new unplanned skills, for instance to solve problems the automation has any influence in the behavioural intentions to use BPAuS technology. At all the sites that implemented BPAuS, a new responsibility was created to monitor the automation and solve issues if the automation failed.

6.4 Category: Social Influence

Social influence is the degree to which a person believes they should use the technology, the influences of other people and the motivation factors to comply (Bozan et al. 2016). The existing social questions (see Table 8) were explored against BPAuS technology.

Across the four sites where the technology was implemented (see Chapter five), the findings highlighted that when the automation worked correctly and produced the desired output, then workers trusted the technology. Although the premise is that in a workplace setting, a worker has no choice in using the technology, the findings highlighted that workers potentially had some influence over the choice, with managers making the final decision on whether to use the technology. This was evident at the two sites (Contract and Payroll) where the automation moved into abeyance, with the managers stated they required more time to consider the implications of using the technology before any implementation. At both sites, the managers had taken into account the concerns raised by workers regarding losing the skills and knowledge to take over manually if the automation failed. A further concern related to new workers joining the team that would not have any prior knowledge or skills to step in. Contract.Manager1 saying

"more worrying are the new workers joining the team in the future, they would not have any previous experience to step in [if the automation failed]"

The managers at the Contract site felt they needed certainty that there were clearly defined contingency arrangements in place in the event the automation failed, this was because of the legal requirement to issue contracts and requirements to comply with tax and national insurance legislations. The risk consequence varied across the sites. In the event that BPAuS failed then it was not clear to the managers which worker could support the automation to ensure it still worked.

At the four sites where the automation was deployed, the workers were not given any training on how to fix problems when the automation failed. These skills were learnt on the job because it was not envisaged issues would arise with the automation and as a consequence no training material was considered to support workers. The findings did not highlight the need for any additional questions to test this category.

6.5 Category: Facilitating Conditions

The facilitating category relates to the belief that there is organisational and technical support for the technology (Yu 2012). The spread in responses against the category highlights different participant views on the impact of the technology on resources, skills and the job. For instance, question 20 (see Table 8) assesses whether a worker could continue to perform the task if the automation stopped work. The responses ranged from most participants nether agreeing/disagreeing to the statement, with some participants strongly agreeing with the statement.

A review of the existing questions (18 to 23) against the category and the findings presented in chapter five highlight these questions do not capture nuances associated with BPAuS technology, for example, a requirement for the automation to work is the need for all the data to be available and in the correct format. If this was not the case then automation would fail. The findings highlight that two additional types of questions are required. Firstly, a question on the quality of the data to be processed. This question is to explore whether the automation processing conditions are in place to ensure the data is accurate, consistent, complete and relevant to support the successful automation implementation. This was relevant across the four sites where the automation was implemented and the shift in the balance of work to cleanse the data before BPAuS used the data. Secondly, a question on the control of software updated to applications used by BPAuS. This question is to explore whether the manager or worker has any control over the frequency and nature of the application changes made to the systems used by the automation. This was particularly relevant at the Contract site and Payroll site where they used an external Recruitment system and Payroll system managed by a third party supplier. The sites had no control over when suppliers provided software updates for their applications which could impact on the automation ability to work.

6.6 New Category

The findings highlighted that there are additional considerations not covered by the existing questions of the UTAUT model that may influence the intentions to implement and use BPAuS technology. Reported at the Statement site, the managers mentioned there were missed savings opportunities for the department to recover income in the form of credit notes from suppliers. This was not being collected due to staff workload and not having the time to identify when credits arose. Although this may be a specific consideration for managers rather than workers, what has not been asserted in the study is whether the workers received any benefits, for instance a bonus payments based on achieving savings target. Separately, reported in the Statement and Rostering sites, there were savings opportunities for managers and workers to be realised based on the post-automation findings (chapter five). The automation freed workers to perform other duties, reduced pressure on workers, whilst also reducing the resources required to perform the task. The opportunities for managers were the savings from not having to employ temporary workers during periods of peak demand.

Adding a new category ‘Savings Opportunity” could extend the use of the model to a different context (i.e. use of BPAuS technology). On the basis of the evidence from this research two new questions for the new category are posed: firstly, a question relating to the potential income to be generated. This is to assess any opportunities in realising income from using the technology. For instance, at the Statement site, prior to automation they were not recovering early repayment discounts from suppliers or processing credit notes from suppliers in a timely manner due to existing workload. Secondly, a question on net resource savings. This question is to evaluate any savings to be made from reducing the time spent by workers on tasks and in turn, freeing the workers to perform other duties. The savings will be offset against the ongoing cost of using the BPAuS software and maintaining the automation system. In the case of the Roster site, the delivery of the automation meant that the department did not need the temporary worker to assist them during peaks in demand, therefore giving rise to savings because of job loss. Although job losses make for more resistance to use the technology, the managers at some of the sites did not view the use of the technology as a job loss. Their focus was to ensure as the volume of work increased this could be managed by the automations and existing permanent workforce, avoiding the need to recruit any additional permanent or temporary agency workers. The permanent workers did not view BPAuS as a threat to their job, however, it is unclear whether this was also the view of the existing temporary workers.

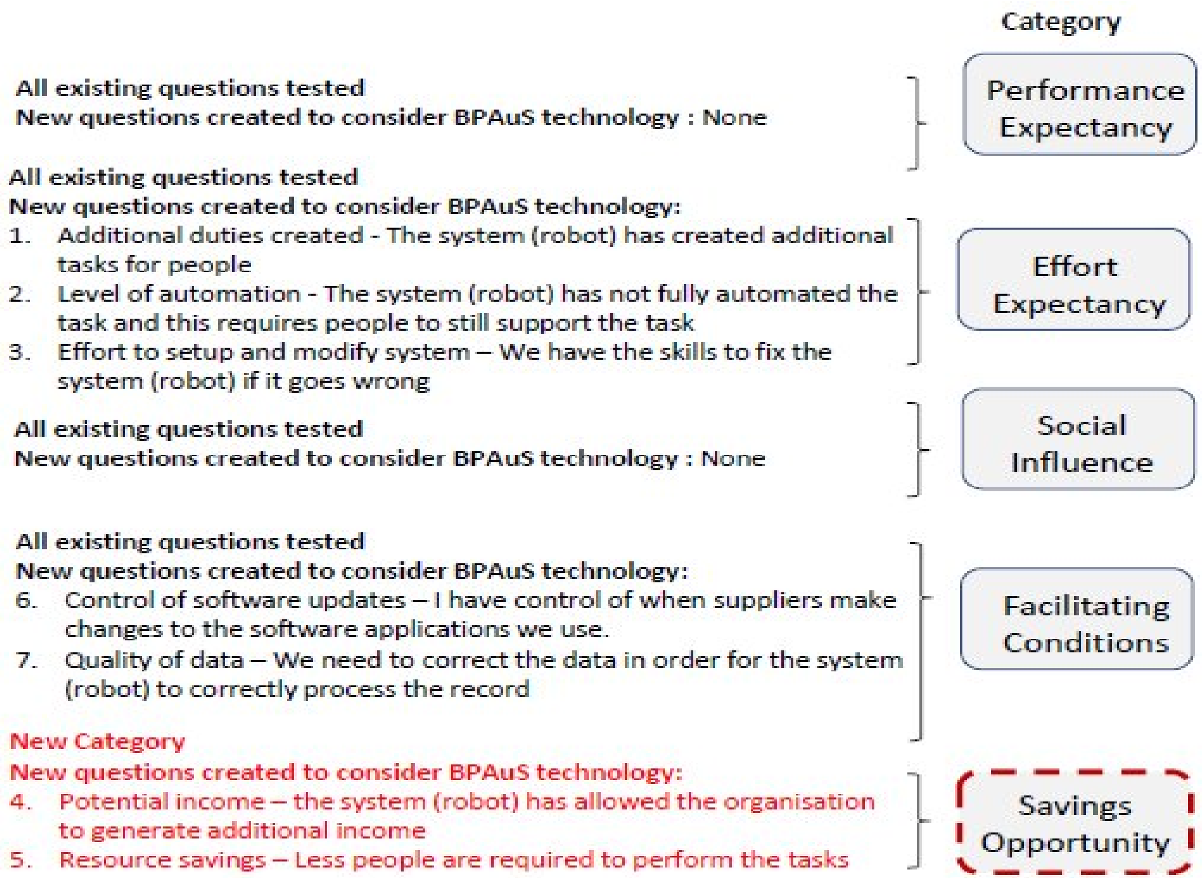
6.7 Conclusion

This chapter has reviewed the UTAUT model applied to BPAuS technology. The findings highlight that the UTAUT model captures many of the key categories and associated questions necessary to assess BPAuS technology. An analysis across the cases highlight that five new questions are required against two of the existing cateogies (effort expectancy and facilitating conditions). The new questions include evaluating the level of automation delivered and the quality of the data to be used by the automation. The findings suggest the need for a new category 'Savings Opportunity' and associated questions for inclusion in the model. This is to provide an additional factor that may influence a decision to implement the technology. At the Statement and Rostering sites where saving opportunities were identified, the managers stated that they were now dependent on the BPAuS technology and would be concerned if the automation stopped working. One of the reasons for the dependency is the savings being realised by the departments. This makes the new category a strong factor that may influence the use and acceptance of BPAuS technology. As discovered at the two sites that moved their automation into abeyance, the workers views were taken into account and there is a balance between savings to be made and the risk to the organisation if the automation failed.

It is important to consider whether some of the questions, for instance on savings opportunity are more pertinent to managers than workers. The new category and the seven new questions need to be tested in a future study to explore whether they further support the testing of UTAUT model against BPAuS technology. To reflect the findings highlighted, the revised structure of the UTAUT model that would be required to support the future empirical testing of the BPAuS technology is presented in Figure 17.

Figure 17 – UTAUT model additional questions and categories to test BPAuS technology

(Adapted from Venkatesh et al. 2003)



Chapter Seven: General Discussion

7. 1 Introduction

This chapter draws together the findings from the six case studies and relates these to the literature and frameworks to explore the three research questions. The next section (7.2) explores the first research question on the main determinants that influence automating jobs. Section 7.3 explores the second research question which focuses on the effect of software agents on job design. Section 7.4 explores the third research question about the suitability of the UTAUT model to explain workers intentions to use BPAuS technology. The last section (Section 7.5) provides concluding remarks.

7.2 Automating Jobs

This section assesses the first research question which is to understand the main determinants that influence the deployment of software agents in the workplace setting and whether this can be explained through existing frameworks and models. To address the research question, the next two paragraphs assess the extent jobs were automated and the impact of software agents on jobs and the organisation. This is followed by examining the three main considerations for job automation and whether this can be explained through the adapted Parasuraman et al. (2000) framework and Kaplinsky (1985) model used in the study. The remaining paragraphs explore three additional considerations impacting on the use of BPAuS that are not addressed in existing literature on technical and social relations between people and automation technologies.

To what extent were the jobs in this study automatable? The evidence from the case studies shows that it is not the whole job that is automated, as argued by Ford (2015) and Frey and Osborne (2013), but specific tasks, such as where the task is routine and repetitive and involves data entry into an application (Autor 2015; Arntz et al. 2016). Significantly, in some cases it is not even the whole task that is automated, only elements of the task, which is not discussed by Autor (2015) and Arntz et al. (2016). For instance, at the Contract site, data relating to employment contracts for medical jobs and very senior manager jobs were more complex and required worker judgement to create the contracts. Therefore, these were not suitable for the automation agent to process. Automation was seen to complement skilled labour, with some substitution of unskilled labour (Autor et al. 2003; Arntz et al.

2016). The findings indicate that a small number of lower paid and less qualified jobs in the NHS (for instance clerical and admin roles) were being replaced with automation, in particular temporary workers that performed specific tasks only. This was evident at the Statement and Roster site, where the automation was able to work 24 hours a day, seven days a week and able to handle any peak workload demands placed on the organisation. Although job losses make for more resistance to use the technology (Nam 2018), the permanent workers did not view the use of the technology as leading to job loss. This may be because as permanent workers they did not see their jobs being threatened compared to the temporary workers. Instead the permanent workers viewed automation as a solution to ensure that as the volume of work increased then this was managed by the automation. This was despite the automation replacing the temporary workers previously required to manage the increased workload.

The study found software agents had an impact on jobs and the organisation, with the automation outperforming workers at certain tasks, delivering greater accuracy and this provided benefits to the organisation. One of these benefits was the observed unintended consequence of reviewing and documenting existing processes: sites identified some unnecessary tasks being performed in the process and this provided an opportunity to streamline existing processes and reduce task complexity to deliver greater operational efficiency before they considered automation. For example at the Catalogue site, it was found that the same checks on suppliers were performed by several teams using the same application system, rather than being performed once. The finding is similar to other studies that explore streamlining business processes to increase worker throughput by reducing human variability and human errors (Black and Lynch 1997; Didham et al. 2004; Stead and Lin 2009; Dolci et al. 2017). However, what is new in this research is the consideration to implement automation as the driver to review business processes rather than specifically to address worker throughput, variability and human errors. A further identified benefit was how the use of the BPAuS technology allowed workers to spend more time addressing customer queries which improved the quality of service provided to the customers and this led to more satisfied workers. This supports Willcocks and Lacity (2016) findings that software agents allow workers to focus on the more interesting tasks requiring social interaction, judgement and empathy. There were also instances where the technology saved money in staff time, however, it is unclear from the study what the costs was to implement and manage the automation. One drawback of the technology was the need for workers to review and address any quality issues with the data before it was processed by the automation. This was to prevent the automation from potentially failing.

7.2.1 Adapted framework

The adapted Parasuraman et al. (2000) framework (see Figure 16) comprising the three stages of automation design proposed in light of the research was found to further the understanding of the impact of automation on work, job and skill characteristics. The framework was followed across all the case study sites, and each of the three stages of the framework (types of tasks receptive to automation, levels of automaton and automation acceptance) are explored next. Firstly, the study found that there was uncertainty to the types of tasks suitable for automation, with some sites (for instance Catalogue site) expecting BPAuS technology to be able to automate more of the process than was actually achieved. This may be because of the marketing hype, with suppliers claiming the technology can automate entire processes. In the case studies, the implementation of software agents was limited to simple, repetitive tasks where there was little or no judgement required in the activities being performed, as identified by Lacity et al. (2015b) and by Parasuraman et al. (2000) in the original model. However, the findings suggest that three new criteria are required when selecting tasks for automation: complexity and quality of data; frequency and extent of changes to the software applications used by the automation, and risk to the organisation if the automation failed. These criteria were unexpected because they are not addressed in literature or in existing models. Although existing literature explores automation risk in terms of safety risks and the impact on the organisation, for instance in aircrafts and vehicles (Wiener 1989 and Banks and Stanton 2016) the literature does not address risks of BPAuS technology on the organisation. The new criteria highlight further areas that need to be carefully considered on the automation journey.

Secondly, in terms of levels of automation, the study initially used Vagia et al.'s (2016) eight levels of automation (LoA) in the Parasuraman et al. (2000) framework (see Appendix C, Section C1). Having eight levels was found to be difficult for participants to relate to when assessing the extent an existing business process could be automated. The study created a new five LoA model (see Appendix C, section C2) to simplify the categories and this worked well and helped participants to judge the extent a task was automated compared to being performed manually. However, there was some difference in how workers and managers assessed the extent tasks were automated and the LoA delivered for the task. For example at the Statement site, it was reported by managers that the task was no longer performed by the workers (delivering 100% savings on perform the task), however, the workers reported the LoA delivered was between one and three (between 25% and 75% performed by the automation) for the task. This is an area worthy of further investigation. The revised LoA can be used and tested for other automated studies.

The study highlights that one vital factor influencing the LoA delivered is the quality of the data the software agent was expected to process. There are various forms of data issues that can arise, including data format and completeness, which could result in the automation failing. This is because the software agent does not possess the capability to make judgement on the data. These findings support studies such as Falge et al. (2012) and Cappiello et al. (2015) that highlight the importance of data quality from a process management perspective and the need to use judgement when processing poor data, the impact this may have on performing a business process correctly and in making the right business decisions. In this study, poor data could not be used by the software agent because it does not have the capability to apply judgement. In these situations workers were required to process the data. All the case study sites were sensitive to the data provided and this amplified the number of times the automation stopped working, requiring a stop start approach to the implementation, testing and support. One approach observed at two case study sites (Contract and Payroll) to address data quality issues was to review existing processes and where possible to redesign the processes to deliver improvements in both processes and the quality of the data being captured.

Thirdly, in terms of automation acceptance stage of the adapted Parasuraman et al. (2000) framework, due to the nature of how BPAuS technology was implemented, workers at the Roster site did not believe they were working with a software agent to complete the process outputs and therefore gave no consideration to what activities the software agent performed or how it would report back any information to the worker. Yet the workers at the Catalogue and Appointment sites were aware that they were preparing data files for the software agent and the need to ensure the files were correctly formatted and stored in specific folder locations for the software agent to use when performing its tasks, otherwise they recognised the automation would fail. Not knowing whether a worker is interacting with a software agent has potential implications for the UTAUT model (see Section 7.4).

7.2.2 Additional Considerations

Section 7.2.1 explored the relevance of the three stages of the adapted Parasuraman et al. (2000) framework. There are other considerations impacting the use of BPAuS that are not addressed in existing social science, computer science and system science literature on automation. The remainder of this sections highlights three additional considerations.

First, BPAuS technology is not straightforward to implement, even for simple tasks, and not something that can be delivered quickly (i.e. within days or weeks) (see Figure 15). Existing literature overlooks the issue of implementation timescales of software agents or related types of technologies and therefore there was no opportunity to compare and contrast the findings from this study with other studies. It is unclear whether there is an assumption the technology is simply ‘plug and play’. In the case studies, automation took between six and eighteen months to be embedded or fully run across the sites. It was observed that some departments moved to implement the technology too quickly, without fully assessing what had to be addressed before any automation build commenced.

Studies exploring other forms of human-machine automations, for instance in automated guided vehicles (BačÍK et al. 2017; Pedan et al. 2017) highlight that the implementation of simple automated systems to move laundry across hospital sites can take several years (Lloyd and Payne 2021). In the case of autonomous vehicles, the implementation of even partial automated systems can be complex and take many years. This is because of safety and resilience that must be built into the automation and the testing of all situation scenarios given the potential impact on human life if the automation fails and the human cannot take control. The timescales to deliver fully autonomous vehicles remains uncertain (Banks and Stanton 2016).

Second, a vital consideration in automating jobs is to assess the quality of existing process documentation to ensure it reflects actual processes being performed. The documentation must be described to a granular level, detailing every possible process scenario, and all keystroke activities. The quality of the documentation is important because this is what the development team use to design, build and test the automation. Any gaps in documentation could result in the automation not being correctly built and possibly not performing tasks appropriately (Müller 2019).

Third, it is important to understand the extent and frequency of feature and functionality changes to external software applications used by the software agent. The study found that changes to these applications could result in the software agent failing or not performing tasks correctly. This would require workers to understand the impact of the change to the software agent and to know what changes would be required to existing process documentation. Some of these application changes were outside the control of the department because the application is owned and managed by a third party company that may introduce new features at short notice. The extent of the changes could have implications for how quickly the software agent could be re-deployed, requiring workers to ensure they have the knowledge to perform the task manually in the interim. It may be that the workers with the knowledge, for instance agency staff are displaced, posing a risk to the organisation if workers cannot step in when required to perform the task. Although studies such as Wood (1996) highlight that automation designs should fully address the nature of potential issues that can arise and be foreseen, the findings associated with BPAuS technology highlight that this was not always possible. Though some potential problems can be foreseen, it is not always possible to predict future changes required and pre-build these into existing automation design. The discussion on automation design and the key considerations is explored further in the next section.

7.3 Job Design

This section assesses the second research question and examines how software agents affect the three characteristics of human agents: job (task variety, responsibilities and job demands), work (challenges, resources, output and outcomes) and skills (job complexity, qualifications and skills).

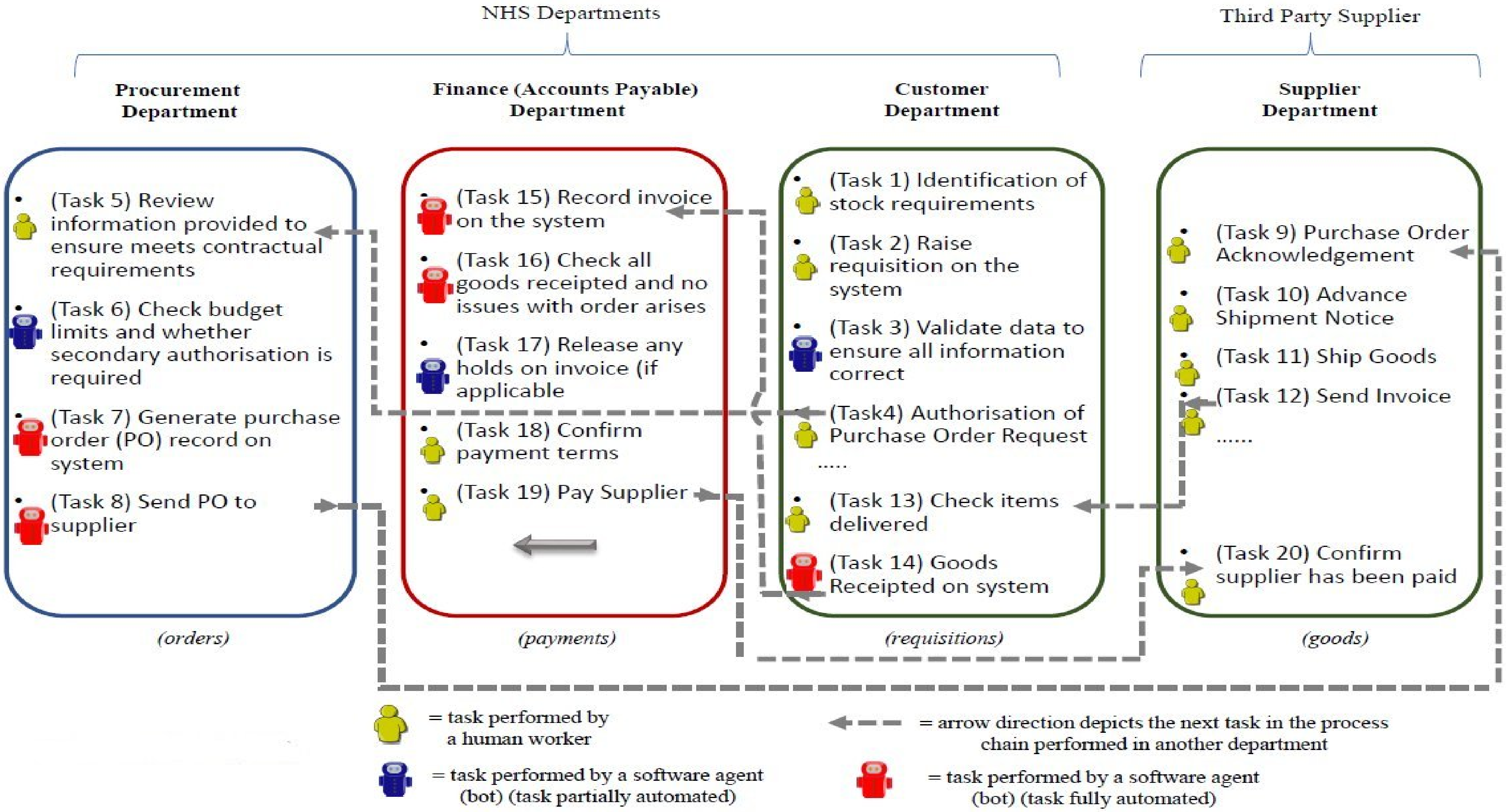
7.3.1 Job Characteristics

First, the study identified some changes to job characteristics. All the workers affected were lower graded clerical workers, in jobs that do not require qualifications on entry, with training provided on the job. The jobs for the permanent workers comprised of a variety of duties. In the case of temporary and agency workers, they were predominantly performing specific routine and repetitive tasks to allow departments to manage increased/variable demand. The introduction of the software agents replaced much of this work.

The findings did not support Ho et al.'s (2019) claims that the organisation of work resulted in the creation of new types of job roles or workers being reskilled to perform new jobs. Neither was there evidence in this study of Frey and Osborne's (2013) proposal that entire office and administrative support workers jobs will disappear. One of the motivations to introduce automation was overstretched resources to manage demand, complete activities on schedule, requiring more workers to expand provision. The findings support Arntz et al. (2016) and Davenport and Kalakota's (2019) position that automation will not destroy large numbers of jobs, and what impact there is will be on lower paid and less qualified workers.

For permanent workers, there was a rebalance of tasks, with workers spending additional time early in the process to check and correct anomalies with the data to ensure the automation did not fail, and dealing with customer and supplier queries. Most workers preferred the revised job because it reduced pressure on them to meet deadlines, with the software agent dealing with some of the demands. Their jobs still provided a variety of manual tasks to be performed, requiring judgement, empathy and social interactions (Willcocks and Lacity 2016). Workers had new responsibilities to monitor the software agents and fix the automation when it failed.

Figure 18 – Process and task collaboration between human and software agents (Procure to Pay)



The findings support Braverman's (1974) notion that the labour process is compressed with less manual steps to perform to complete the process chain, with workers having a narrower range of tasks to perform after automation, unless the nature of the job is changed. This is illustrated in Figure 18, that takes the 20 tasks manually performed as part of the Procure to Pay manual process (see Figure 4) and highlights specific tasks that may be automated fully or partially. A task that becomes fully automated narrows the range of manual tasks that still need to be performed. In accordance with the Kaplinsky's (1985) 'intra-sphere automation' model any adjacent tasks that are fully automated (for instance tasks 15 and 16) could be combined into a single enlarged automated task. As more adjacent tasks become fully automated then these could be combined into the existing enlarged automated task rather than being treated separately. The approach to merge tasks reduces the complexity of automation design because there is less need to consider passing activities between adjacent software agents.

Further insights into job characteristics is the understanding of human-computer interaction and human-centred automation design. There is a broad range of literature exploring the interaction between a human and a software agent relating to a specific task or activity, for instance Young et al. (2007) on airplane autopilot, Parasuraman et al. (2009) on autonomous driving vehicles and Hinds et al. (2004) on collaboration with physical robots in the workplace. Literature also discusses the approach to ensure the human is placed at the centre of automation design (Yi and Hwang 2003; Sanders et al. 2011 and Grote et al. 2014). These studies consider control, accountability, risk and safety factors, as well as the type of interaction required and situation awareness of the human operator to monitor the automation. These considerations can typically involve complex design, taking many years to implement.

Whilst the human interaction with BPAuS technology provides some similarities to other forms of human-centred automation design, for instance the need for control and the time taken to implement automation, the observations also show there are some new considerations. This is because software agents can sometimes work unattended especially if operating 24 hours a day, seven days a week and there can be joint boundaries of responsibility between agents, for instance sharing of data files and communicating information. The nature of risks to be managed and safety considerations can be different, for instance if tasks are not fully automated (i.e. at automation level five) and there is an issue with the data when the software agent works unattended. In this situation the consideration is whether the software agent rejects the data and moves onto processing the next data record or whether it should stop the process chain and wait for human intervention. If the nature of the business process is critical to the organisation and worker intervention is immediately required to correct the data then the workers' job would need to be designed to monitor the automation 24 hours a day, seven days a week.

The success of all tasks in the process chain requires confidence in each agent performing their tasks successfully. The study found that trust in the software agent took time to develop and this was conditional on the automation working and delivering the outputs expected. For example at the Rostering site, once the software agent was trusted, workers then became reliant on the automation performing as expected (i.e. suitably, reliably, competently, accurately), performing the activities required and for the intended purpose. With BPAuS technology, having trust in the technology can also lead to complacency and lack of proficiency situation for the worker to step in and take control, especially if the automation fails for reasons outside the automation control, for instance if there was a problem with a software update or incorrect data. The dependency on the automation could arguably lead to the same complacency and lack of proficiency, a situation reported by Wiener (1989) on pilots of Boeing 757 aircrafts. Wiener (1989) reported that pilots became reliant on the automation of the flight guidance process, for instance during airplane take off and in heavy storms and this led to automation complacency, loss of ability to perform all the activities rather than those specific aspects not automated. The findings reported on trust and complacency when using BPAuS align with some of the challenges with task automation reported in literature (Inagaki 2003; Lee and See 2004; Parasuraman et al. 2007; Parasuraman et al. 2009; Parasuraman and Manzey 2010).

7.3.2 Work Characteristics

Second, the study identified some changes to work characteristics. At the four sites that implemented BPAuS technology, the results (see Table 10) indicate that departments were expected to save between 0.11 FTE and 2.5 FTE in staff by automating the task. This equated to between 770 hours and 4,576 hours of works time saved per annum, allowing workers to be redirected to perform other tasks within the job. In the case of agency workers at the Rostering site, this was 100% of their jobs automated with the agency workers no longer required. At the remaining three sites, between 21% and 69% of a worker's activities were automated. This broadly supports Chace's (2016) claim that certain jobs can have at least 30% of their activities automated. The amount of time saved depended on the nature and complexity of the task to be automated and the volume of data to be processed. All the tasks, whether simple or complex required data files to be checked and to fix issues when the automation failed. However, the findings highlight that at all sites there was a rebalance of where the workers spent their time.

7.3.3 Skill Characteristics

Third, the study identified some changes to skill characteristics. There was evidence that the workers were gaining new skills without being given formal training, in particular to monitor the automation and problem solve to fix issues with the data when the automation fails. Workers felt it was quicker to fix issues through learning by doing than wait to be provided with training. The study did not explore the implications of workers trying to fix issues without training and whether any degradation of knowledge of the process over time would have implications on workers ability to fix issues without training. Workers were expected to apply their existing knowledge of the tasks and data to identify the potential cause of problems with the automation. Fixing automation issues were typically found through trial and error and applying changes to see if it worked. If the issue were not related to data files then the problem was passed to the IT development team to solve the issue. The nature of the new skills and the issue with training was similar at all the sites that implemented BPAuS technology. However, workers did not complain about the lack of training because solving issues provided variety to the role. Learning new skills to support automated systems without being given appropriate training are claims made in other studies, for instance Helldin (2014) looking at aircraft autopilot systems and the need for the pilot to intervene if the autopilot system failed or provided warning alerts. At all the sites, no comment was made by managers or workers on whether there would be an ongoing requirement to problem solve issues with the automation. It is unclear from the study whether workers could problem solve issues if they did not have knowledge and skills of the tasks now automated. The study aligns with Hinds et al.'s (2004) assertion that as automation increases in the workplace, there is greater reliance on the relevant skills by people and automation to perform tasks. If knowledge is lost and updates need to be made to software agents due to changes to existing business processes or changes to features and functionality in applications used by the software agents, then who is able to ensure the appropriate changes are made to the software agents? To ensure workers maintain knowledge and skills, there is need for ongoing re-training to manually perform the task now automated. This is evident in other studies such as by Wiener (1989) and Cummings (2006) that highlight some of the issues that have arisen when automation fails and the consequences when the worker is not trained to take manual control of the situation. One of the recommendations from these studies is to provide workers with continual training, including on the activities now automated. None of the case study sites have given any consideration to ongoing training for workers and are presently reliant on existing workers' knowledge and on existing operating procedure documentation. The study does not support Zuboff's (1989) position that automation can introduce greater predictability, ensuring tasks are completed without the concern of workers requiring the necessary skills or knowledge to perform the task.

Within the current literature there is an assumption that digital technologies will radically transform jobs and that it will be predominantly upskilling or deskilling (Barrett et al. 2011 and Smith 2016). This study challenges these narratives, highlighting that at no site was there a consideration to redesign existing jobs or workers' roles beyond the rebalancing of tasks and workers gaining new responsibilities to solve issues with the automation. The main focus for the organisation was to explore relevant tasks that could be automated to free the worker to complete other duties they previously did not have time to complete. There was evidence that freeing the workers improved the quality of service provided, for example workers spending more time dealing with customers, performing checks and controls on documents. The workers did not receive a pay rise or regrading of their existing roles from gaining new skills to solve issues, fix automation failures and from taking on new responsibilities to monitor the automated system, that Simon (1977) claimed would happen when new skills are gained to maintain automated systems. The reason for not receiving a pay rise is understood to be because the nature of the job remained the same, with the main change being the rebalance of work following automation.

7.4 UTAUT Model

This section assesses the third research question on the suitability of the Unified Theory of Acceptance and Use of Technology (UTAUT) model to explain workers' intentions to work with BPAuS technology. The UTAUT model was explored in the technology acceptable stage of the Parasuraman et al. (2000) adapted framework. The section is structured into three areas, first, to explore the suitability of the UTAUT model and whether the model captures the key elements for use against BPAuS technology, second, the observations identified in the findings relating to whether workers had a choice to use the technology and third, the opportunities with new insights the model provides.

The UTAUT model was found to be missing several important questions and a category associated with the nuances of BPAuS technology. The findings suggest that a number of new questions should be added to the existing UTAUT model, see Figure 17. A new 'Saving Opportunity' category should be added to reflect the opportunities in the form of resource savings, income being generated and benefits the BPAuS technology is expected to deliver.

The main focus of the UTAUT model is people's intentions to use and accept technology. This relates to situations where people directly interact with the technology, for instance via a mobile phone, a software application or digital device. Assessing the UTAUT model in the context of BPAuS technology provided useful insights into whether the model captures the key elements to evaluate workers' intentions to use the technology. The findings highlighted an interesting phenomenon, with workers in some cases not realising they were interacting with a software agent as part of completing the business process activities. This is likely to be due to the nature of the tasks being performed and how the automation was designed to pass activities between workers and software agents. With BPAuS technology, the interaction with human workers may be via a number of channels, including access to shared files on a network drive, accessing the same applications or through email communication. In these cases, the human worker would not necessarily know if the communication or data file updates came from another human worker or a software agent.

Having no interaction with a software agent or not knowing if the interaction is with a software agent has potential implications for models of acceptance and use of the technology. Models may need to explore how software agents are implemented to determine the extent of any human-software agent collaboration before considering its suitability. Exploring whether the human worker needs to know whether they are interacting with a software agent and whether moral or ethical considerations arise was the subject of Rivas et al.'s (2018) study on intelligent online "chatbots" (software applications). Their study identified people judge bots with the same standards of morality as human but with a smaller scale of blame if the bot is unable to answer a question or provides the incorrect advice. Studies by Valério et al. (2017) and Chaves and Gerosa (2019) highlight how some organisations inform people when they are about to communicate with a software agent, giving them the choice on whether to continue with the communication or be directed to speak to a human person. An implication arising from this study is that workers should be made aware of any interactions with a software agent. This is important in a workplace setting if issues arise with the automation or with the process. Being aware of interactions with a software agent allows the worker to take the appropriate action rather than assume the next agent in the process chain will know what to do, especially if it is a software agent.

Although it may be argued that workers had no choice but to use the technology in a workplace setting, it was observed that workers at several sites had some influence. The findings highlight that workers at the two sites where the project moved into abeyance (Contract and Payroll) had some influence over the choice about whether to accept and use the technology, with managers making the final decision on whether to implement the technology. The managers took into account workers' concerns about skills and knowledge being lost in the future if the automation stopped working and they had to step in and perform the task. The managers also considered the risk to the organisation if the task could not be completed in a timely manner.

Worker influence over decisions was not evident at the four sites where the automation was implemented. Managers notified workers on the plans, timelines and the approach and workers had to accept the use of the technology. Workers at these four sites did not report that they viewed BPAuS as a threat to their jobs and therefore may not have raised any concerns. One possible reason for the difference in the decision taken to the two sites that did not implement BPAuS, is the organisation risk reported at the two sites if the automation failed. The risk would be an important factor in the decision taken by managers. In cases where workers have no choice to use the technology, then the UTAUT model may not be suitable to measure technology acceptability. However, the model could still be useful to understand the nature of the interaction and factors influencing the use of the technology.

The use of the UTAUT model with the new questions and category developed in light of the research, has provided new insights into understanding how workers and managers interact with BPAuS technology in a workplace setting and the nuances associated with the technology. For instance, the extent of any collaboration and dependency that exists between human-software agents, with some workers indicating they did not interact directly with the software agent and some sites now reliant on the software agent to complete activities. Future testing the UTAUT model is difficult if workers do not know they are working with a software agent (directly or indirectly). This has potential implications on the usefulness of the model. One potential need is to revise the model to explore how the software agent is implemented to determine the extent of any human-software agent collaboration.

All the case study sites stated that one of the reasons for using BPAuS technology was to manage existing workloads and demands, however, there were resource savings in staffing and income opportunities that resulted in a new 'Saving Opportunity" category being proposed for the UTAUT model. The model was not updated and tested during the study to ascertain the effectiveness of the new category (Saving Opportunity) and additional questions. To test the model will require a sample size that is large enough to provide confidence in the model's correlation analysis results. This may not always be possible in a workplace setting and will also depend on the nature of the technology being introduced.

7.5 Conclusion

This chapter has reviewed the findings from the six case studies, highlighting that in terms of automating jobs, it is not the whole job that is automated but specific tasks and, in some cases, not even the whole task. In terms of job design, there was some impact of automation on job, work and skills characteristics. The study found that modifications were needed to the UTAUT model to consider BPAuS technology.

Chapter Eight: Conclusion

8.1 Introduction

The aims of the research were three-fold: firstly, to understand the main determinants that influence the deployment of software agents in the workplace setting and whether these can be explained through existing frameworks and models; secondly, to explore how software agents affect job characteristics, work characteristics and skills; and thirdly, to assess the extent to which the Unified Theory of Acceptance and Use of Technology model (UTAUT) captures the key elements which explain workers' intentions to work with and use software agents. The research empirically examined the implementation of software agent technology in the healthcare sector through six case studies pre and post-implementation in a workplace environment.

The next section provides an overview of the key findings relating to the three research questions (Section 8.2). This is followed by a summary of the thesis's contribution to academic debate and practice (Section 8.3). Strengths and limitations of the study are then reviewed (Section 8.4), followed by an outlook for future research (Section 8.5), with the final section (Section 8.6) providing concluding remarks.

8.2 Key Findings

In reference to the first research question to understand the main determinants influencing the deployment of software agents, the findings highlight that the implementation of software agents is not straightforward and it is not something that can be delivered quickly. There are gaps in existing literature exploring the speed of automation implementation. Organisations should have realistic expectations and not be swayed by marketing hype. Whole jobs are not being automated, and in some cases not even whole tasks. BPAuS is sensitive to the data and only suitable for simple and routine tasks where all the data used by the automation is in the correct format. More complex tasks and data require additional support, for instance workers needing to address data quality issues or intervene.

The adapted Parasuraman et al. (2000) framework (see Figure 16) with the three stages of automation design (types of tasks receptive to automation, levels of automation and automation acceptance model) and the Kaplinksy (1985) model can help to explore the extent to which jobs are automated and the determinants (skills, job and work characteristics) influencing the use of BPAuS technology. The findings highlight three barriers not addressed in literature that would make tasks less for automation: a) if the nature of the data is complex and there are quality issues with the data then the implementation will stall unless a worker can address these issues before the automation; b) if the task is critical to the organisation and workers cannot easily and quickly intervene to fix or perform the tasks manually then the task may not be suitable for automation or c) if the software application used by the software agent frequently changes.

In reference to the second research question exploring the effects of software agents on job, work and skill characteristics, there were benefits to departments and workers in automating the mundane, routine and repetitive tasks, with automation having some impact on job, work and skill characteristics. There was no evidence of any significant impact on job design, job complexity and qualifications with job changes being incremental and small scale contrary to expectation in the literature (Barrett et al. 2011; Smith 2016). Workers were learning new skills to manage the automation and solve issues when automation failed but learning was on the job, and there was no pay rise or job grade change. There was a rebalance of work, away from repetitive tasks to workers spending more time addressing data quality issues, and other task they previously did not have time to perform. These changes were found to increase worker job satisfaction and reduce work pressure. There were a small number of job losses arising from automation in some of the cases, reflecting reduced requirements for temporary workers during peak periods. One future challenge is the prospect of a loss of worker knowledge in being able to take control manually if the automation failed and the lack of appropriate training, something debated in existing literature, for instance in pilot systems (Helldin 2014).

In reference to the third research question relating to the UTAUT model, new questions required to be added to the existing UTAUT categories and a new category ‘Savings Opportunity’ is required, reflecting the nuances associated with BPAuS technology. The model captured the key elements to explore workers’ intentions to use and work with software agents. However, it is necessary to understand how BPAuS technology is implemented as this could have implications on whether workers need to know if they are interacting with a software agent. The findings add to the limited number of empirical studies that exist to assess the extent of the interactions that can occur between workers and software agents in an office workplace setting.

8.3 Contribution

The research contributes to the academic debate and knowledge on automation, with four key messages. First, the extent of any job losses continues to be debated in literature (Frey and Osborne 2013; Autor 2015; Ford 2015; Arntz et al. 2016), with this study finding that job losses were limited to areas involving additional temporary workers to support periods of high workload demands. In most cases, BPAuS technology was about task automation and not process automation and this resulted in the rebalance of work, with automation freeing the worker to have more time to perform other duties they did not have time to complete.

Second, the study has developed and assessed a revised five level of automation taxonomy model (see Figure 9) to understand the extent task automation is implemented using software agents. The revised model simplifies existing levels of automation models discussed in literature (for instance Endsley 1987 and Vagia et al. 2016) that proposed different taxonomy ranges because of the context and domain in which the automation is used. The revised model reduces the number of classifications which makes it easier for participants to assess the extent a task is automated compared to being performed manually. This in turn provides advances in the development of theoretical models to further the understanding about the degree a task is automated using software agents. This also furthers the understanding on the extent to which human-machine interaction is required in automation design. These developments contribute to the debate on human-centred automation (Young et al. 2007; Kumar et al. 2019).

Third, the research contributes to the continued debate on skill requirements to perform work that is routine and repetitive using a computer system and labour use strategies for automation systems. What remains the same is that workers are continuing to use skills to intervene and perform the task manually when the automation fails. What is new is the troubleshooting skills workers are learning to fix issues with the automation, sometimes without training. What is different is the rebalance of work, with workers spending more time addressing data quality issues before the automation uses the data.

Fourth, the study contributed to assessing the UTAUT model and proposed refinements. There have been few studies examining the model against office administration systems and software agents. The research proposed enhancements to the UTAUT model to assess the usefulness against software agents. The findings indicated a number of new questions were required against existing categories and a new category was required given the nuances associated with BPAuS technology. Future studies can benefit from using the revised model to test BPAuS related technologies to understand people's intentions to use and work with the technology.

The research can contribute to policy and practice by providing additional considerations and approaches on whether to deploy software agents. The deployment of software agents is not limited to any specific organisation or business sector, however, the study focused on NHS organisations and therefore the key takeaway messages on policy and practice are particularly relevant to this sector. There are four key contributing messages on policy and practice.

First, the adapted Parasuraman et al. (2000) framework (see Figure 16) and models provides an IT development team with a structure and approach to use when engaging with managers and workers over the types of tasks to be considered for automation. Not all routine and repetitive tasks can be automated and it is important to consider: the complexity of the data to be processed, the risk to the organisation if the automation fails and the frequency with which the applications used by the software agents change. The framework can help managers understand the degree to which tasks are automated and what this means for staff resources, skills and job design. It is important to set the expectation that automation can take some time to deliver and this may mean deployment is incremental whilst issues with the software agent are resolved. The framework can help organisations to understand the extent jobs can be automated and what this means when designing services. Although the research explored savings in terms of staff resources, the full cost of delivering automation and any potential savings must also consider the cost of implementing the automation, software licenses and the ongoing cost of maintaining and supporting the automation.

Second, it is essential for managers to ensure the completeness of existing standard operating procedure documentation describing the business process to be automated. It is critical the documentation captures every keystroke, fully describes the actions expected by the applications and captures all the scenarios of what could potentially go wrong with the task and how each of these situations should be addressed. It is also important the documentation details what activities are passed between tasks. This level of detail is important to be able to correctly design and build the automation and ensure tasks are correctly passed between software agents and workers. Detailed documentation also provides insight for the organisation and the IT development team to assess whether there are specific complexities in the task that would make it unsuitable for automation. Reviewing the completeness of the documentation provides an opportunity for organisations to assess whether any of the existing activities can be streamlined or simplified in any way before considering automation. It is important for these documents to remain up to date at all times as the process or task changes and to reflect feature and functionality changes in the software applications used by the automation.

Third, the IT development team should find that the simplified five levels of automation model (as developed in this research, refer to Appendix C, Section C2) will assist managers and workers to gauge the extent a process or task is automated or still performed manually. Exploring the level of automation delivered also furthers the understanding of the extent to which human-machine interaction will be required in automation design, in particular focused on how human and software agents interact (Young et al. 2007; Kumar et al. 2019). The lower the level of task automation implemented, the greater the expected level of interaction and intervention potentially required by a human agent to support the automation to successfully complete the task.

A fourth message from this research is that managers need to recognise that workers still need to retain knowledge and skills of the task automated so that they are able to intervene when necessary, and this might entail the need for regular re-fresher training. The intervention could be to manually perform the task and/or to troubleshoot the issue if the automation failed and attempt to fix the automation. If the automation failure is outside the organisation control, for instance due to a feature or functionality change to the application used by the software agent then the worker has to understand the impact of the changes on the existing automated task. This may require the worker to use the knowledge of the task to update existing procedure documentation. The revised documentation would also assist the IT development team to identify the changes potentially needed to the automation to fix the issue.

The contribution to the academic debate and on policy and practice adds to the existing knowledge on software agents in an office environment and supports an assessment of the future of work.

8.4 Strengths and Limitations

The study has brought together existing social science literature with information technology and computer science literature and adds to the existing body of knowledge that explores the social and technical considerations associated with human and automation interaction and collaboration. The research approach based on case study design was suitable to explore BPAuS technology. The approach allowed complex situations to be studied in their natural setting and identified nuances associated with the technology. The number of case study sites and use of interviews and questionnaires provided a quantity and depth of data which allowed the findings to be explored, compared and contrasted across the study sites.

Although this research was carefully designed, there are some limitations. The number of research sites and case studies available was restricted because BPAuS technology was emerging at the time of the study, with only a limited number of NHS organisations and departments securing funding to implement the technology. The study selected all six available sites across the two organisations exploring the use of the technology, an approach which elicits suitable and sufficient data to explore the research questions.

The post-automation data collection exercise was undertaken about three months after the implementation of BPAuS technology. This was viewed as the minimum period necessary to provide a snap-shot of short-term changes that may arise and to understand any implication on job characteristics, work characteristics and skills. However, a future study could explore whether the findings change if the data collection exercise was repeated at least a year after implementation.

There was a constraint on the amount of time available by participants to support interviews during work hours and this put pressure on the researcher. This did not impact on the data collected because the exercise was supported by questionnaires shared with participants in advance of the interviews. However, it is not known if participants limited their responses because of any time constraint. Future research should explore the feasibility of allocating more time for interviews or in some way compensating participants for their time.

8.5 Avenues for further research

The findings provide many directions and opportunities for further research, with the following covering four potential areas.

First, research could explore the use of BPAuS technology in different organisational contexts and settings, to compare and contrast the findings with those from these NHS organisations. This could include for instance a comparison of implementation in the private sector to explore the extent implementation timescales might be addressed differently in different sectors.

Second, if the future research formed part of a longitudinal study, for instance over three years, then it could explore impact on knowledge degradation, skills, work and job characteristics, trust or complacency and whether these change over time. For instance whether there continues to be a rebalance of work, whether new unplanned skills arise and whether any form of upskilling or reskilling takes place. Such further research would assist with understanding whether the benefits and challenges associated with BPAuS technology are similar to other forms of automation technologies.

Third, in the last few years a new wave of BPAuS technologies is starting to emerge that claim to include Artificial Intelligence (AI) and Machine Learning (ML) capabilities to provide the automation with some intelligence to make decisions (Lamberton et al. 2017; Khramov 2018; Mendling et al. 2018). These additional capabilities claim to enable intelligent process automation of more skilled and well-paid jobs (Frank et al. 2019), whilst also potentially addressing some of the issues reported in this study relating to correcting data quality issues (Autor et al. 2003). These capabilities are not presently implemented at any of the sites in this study or any other NHS site in Wales. The extent of jobs and tasks automated and impact on higher paid roles may change with the use of AI/ML capabilities. Future research could explore whether organisations that use AI/ML capabilities alongside the BPAuS technology allows for automation of more complex tasks and data, including whether this applies to an entire process rather than specific tasks, thereby giving rise to implications for skills, work, job roles and job design.

Research into the use of AI could also explore whether these capabilities reduce the number of existing problems with automation, for instance the need for workers to spend more time early in the process to check for anomalies and correct the data, in turn allowing them to potentially be reskilled into new areas, rather than the rebalancing of tasks reported in this thesis. Such research could include assessing whether frameworks such as the adapted Parasuraman et al. (2000) framework (see Figure 16), that includes a revised LoA model, supported by the Kaplinksy (1985) model contribute to an explanation of whether humans are placed at the forefront of any proposed automation activity design and how this compares to the challenges and opportunities that exist for other forms of automation technologies.

Fourth, existing studies have not assessed UTAUT model against BPAuS technologies, and this doctoral research has led to seven new questions against existing categories and a new category to assess BPAuS technology against the UTAUT model (see Figure 14). Future research could test the suitability of a revised UTAUT model with an appropriate sample size to provide confidence in a statistical analysis assessing if the revised model is able to explain people’s intentions to work with and use BPAuS technology.

8.6 Conclusion

This chapter has highlighted the key findings, contributions made to academia and research and explored avenues for future research. There have been few empirical studies exploring phenomena that connect people with BPAuS technology. This research adds to that body of knowledge. The findings and adapted framework and models will be of interest to any organisation in any sector as well as IT development teams exploring the use of BPAuS technology. The findings will also be of interest to policy makers in developing workforce strategies and digital strategies when considering the role of BPAuS technology in supporting the future of work.

The advancement of technology, AI capabilities and in automation agents provides ongoing opportunities for organisations to explore the use of intelligent automated systems to shape the future of work. The acceleration of workplace automation may already be taking place as a result of the present pandemic situation and the need for remote working. For researchers, it provides opportunities to explore the advancement of these technologies on existing frameworks, models, knowledge and on policy and practice.

GLOSSARY

Agent: Characterised as an object that may be in a tangible or intangible form and will have a common goal and objectives. Models of agents include human agent, physical robot agent, automation agent and software agent (digital agent). An agent may comprise of mixed forms, for instance team agents that include human agents and software agents.

Application: Also referred to as "software application" or "app". It is a computer program designed for a particular purpose to enable a user to perform some specific task.

Artificial Intelligence (AI): Intelligence demonstrated by machines to perform tasks normally requiring human intelligence, for instance, decision-making, visual perception and speech recognition.

Automation: "a device or system that accomplishes (partially or fully) a function that was previously carried out (partially or fully) by a human operator." (Parasuraman et al. 2000, p. 287).

BackOffice: "Where the operational support systems for business administrative services are created, managed and delivered." (Willcocks and Lacity 2016, p. 45).

BPAuS Technology: The use of software application that can be programmed to mimic human keystroke activities.

Information and Communication Technology (ICT): comes under the umbrella term "Information Technology", "Information System" and is used interchangeably with the terms: "digitalization", "digital" and "technology", however, it has no single unified definition (Abukhzam and Lee 2010; Barley 1984, p. 43). For the purpose of this study the definitions defined by the Oxford Dictionary is used. Oxford Dictionary (2017) defines technology as "the application of scientific knowledge for practical purposes, especially in industry: advances in computer technology", with Information and Communication Technology defined as "the study or use of systems (especially computers and telecommunications) for acquiring, storing, organising, disseminating, retrieving, and transmission of information" (Fung 2013).

Intelligent System: "Automation of activities associated with human thinking, decision making, and problem solving process." (Dole et al. 2015).

Machine Learning (ML): A subset of AI that to automatically learn and improve from experience without being explicitly programmed.

Organisation: A business firm (company, enterprise) inside an industry that provides goods and/or services. This may be a for-profit or a non-profit business organisation.

Robotic: "any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner." Encyclopedia Britannica (2020).

Robotic Process Automation (RPA): also denoted under the terms: "Software Agent", "software robots" and "software bots". RPA is the delivery of a virtual digital workforce and is defined as the use of software technology and potentially machine learning capabilities that through noninvasive application agnostic orchestration can seamlessly automate manual process activities and tasks undertaken by a human.

Service Automation: Delivery of a business service in a completely automated manner using technology. The processing of events, processes, tasks and business functions.

Software Application (or Application): A computer program or group of programs designed to perform functions, tasks or activities for end users.

Software Agent: See Robotic Process Automation

Virtual: "Not physically existing as such but made by software to appear to do so." Oxford Dictionary (2017).

Worker: A human person that works, usually at a specific job in an organisation.

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APPENDIX A – INTERVIEW QUESTIONS

Appendix A1 – Pre-Automation Interview Questions

Exploring the impact of workplace software "robot" process automation agents on the healthcare workforce.

Manager/Supervisor/Operational Staff –
Interview Question Schedule
PART B - (PRE-AUTOMATION)

All responses are direct quotes provided by the participant unless indicated otherwise

SECTION – INTRODUCTION

1) Name of study participant(s): (a) ………………………………………………………………………

(b) ………………………………………………………………………

2) Interview Date: ………………………………………………………………………

3) What is the study participants existing role (please tick all that apply):

□ Supervisor: the person responsible for overseeing the worker/team performing the manual task

□ Manager: the person that manages the department/functional area performing the manual task

□ Operational Staff: the person that was previously responsible for undertaking (processing) the process/ task manually

In addition, what is the participant role in understanding the process/ task:

□ Subject Matter Export: the person who understands and performs the process/ task to be automated

□ Process Champion: the person who understands the business processes for the department and has an overview of the task.

□ Other (please specify): ………………………………………………………………………

SECTION – INFORMATION ABOUT THE MANUAL PROCESS/ TASK AND EFFORT INVOLVED
In this section I am interested to hear about the process/tasks you perform that will be automated.

1) Can you confirm the name of the business process task/activity that you are looking to be automated?
……

a) Do you want to just describe what the present process is so that we can set some context to the next set of questions please?

……

b) What resources are presently needed to perform the process/ task to be automated (*for instance , staff resources, any engagement with governance groups, suppliers, details of the frequency/schedule to be followed to start and/or complete the task, finances*)

……

c) What activities presently takes place to perform the process/ task
(*for instance are you using any specific tools, technologies, process maps, procedures and what are the specific duties*)
………

d) What skills and knowledge are presently required to perform the process/ task
(participant to *provide as much detailed information as they can, including what element of the duties are routine and what element requires judgement, including any specialist qualifications\accreditations required etc*):
………

e) Describe any constraints regarding when the process/ task must be completed by, how long you have to complete the task, any associated dependencies on other activities?
………

QUESTION FOR MANAGERS/SUPERVISORS ONLY - START

2) Is the entire business process to be automated or a specific set of activity/tasks within the process?
If it is specific set of activities/task then please explain the reason for this decision and which tasks are to be automated and which tasks are still to be performed manually. Please use a separate sheet to provide any further supporting information.
……..

3) What issues, concerns and challenges do you have with the manual process/ task:
----

4) What are the reasons for choosing the process/ task for automation?
………..

QUESTION FOR MANAGERS/SUPERVISORS ONLY - END

5) The next question explores your expectations on the intended output, outcomes and impact from automating the relevant process/ task.

i. Please describe your expectations on the intended output from automating the process/task?
(*these may include for instance: robot would undertake task accurately; consistently; to an agreed quality* and in a timely manner)
……..

ii. Please describe your expectations on the intended outcome from automating the process/task?
(*these may include for instance: resources saved; time/effort saved; staff skills/experience; quality and quantity of the activity; effort expectancy; direct and indirect benefits/consequences on you, your department/division and the organisation*)
……..

iii. Please describe your expectation on any issues, challenges or other consequences that may arise from automating the process/task?
(*the impact may include for instance, intended and unintended changes to the individual, department, organisation; on duties; on job performance and job effectiveness; security/confidentiality challenges and any assumptions you may have on the expected output and outcomes*)
……..

6) How will you assess and measure whether the automation has delivered what you are expecting?

7) The study has categorised the level of process/ task automation based on a scale: 0 to 5. The details of the range and explanation of each level are set out in Appendix (Taxonomies of Automation), refer to the separate supporting sheet.
Based on the range provided, what do you believe would be the expected level of automation you are expecting for the process/ task and what is the reason for your decision?

Business Process Task/Activity	Expected Level of Automation (0 to 5)	Reason for the decision

QUESTION FOR OPERATIONAL STAFF ONLY - START

8) What was communicated to you regarding the process/tasks that would be automated and what this would mean for you, your role duties and responsibilities?
………

9) What do you believe the automation would mean for you and your job role?
……

QUESTION FOR OPERATIONAL STAFF ONLY - END

10) Do you have any additional information about the existing process/ task that you believe may be relevant to the study that has not been captured in the previous questions?

Appendix A2 – Post-Automation Interview Questions

Exploring the impact of workplace software "robot" process automation agents on the healthcare workforce.

Manager/Supervisor/Operational Staff -
Interview Schedule Questions
PART D - (POST AUTOMATION)

All responses are direct quotes provided by the participant unless indicated otherwise

SECTION - INTRODUCTION

3) Name of study participant(s): (a) ……………………………………………………………………

(b) ………………………………………………………………….

4) Date of interview: …………./ …………… / ……………..

SECTION – POST SOFTWARE ROBOT AUTOMATION DEPLOYMENT

In this section, I would like to ask you about your thoughts on the automation now that it has been deployed for a number of months.

Questions:

1) Now that the robot has been deployed, what has the change meant for you?:
Note: to include reference to job satisfaction, motivation, task significance, learning, dealing with others and any particular issues, benefits and challenges. Include how the workers role, skills, duties and resources may have change as a result of the automation and where the staff are now spending their time if the automation is improving their productivity?
……

2) Now that the robot has been deployed, what has the change meant for the role and skills required to perform in the post?:
Note: to include reference to work characteristics
……

QUESTION FOR MANAGERS/SUPERVISORS ONLY - START

3) Now that the robot has been deployed, what has the change meant to the following group of people:

Note: to include reference to work characteristics, job satisfaction, motivation, task significance, learning, dealing with others and any particular issues, benefits, unexpected consequences. Include how roles, skills, duties and resources may have changed as a result of the automation?

a. The person/team performing the task
b. The Manager/ Supervisor
c. The Department/Division
d. The Organisation

……

QUESTION FOR MANAGERS/SUPERVISORS ONLY - END

4) What was the date when the robot first go-live (month and year)?

At go-live was this a full rollout or phased roll out of the robot (Full/Phased)

If it was a phased rollout then:
- i) Why was the rollout of the robot phased?
- ii) What was the date (month and year) that the robot was fully deployed?

5) The study has categorised the level of process/task automation based on a scale: 0 to 5. The details of the range and explanation of each level are set out in Appendix (Taxonomies of Automation), refer to the separate supporting sheet.

Based on your presently understanding of what has been automated for the task, what do you believe is the actual level of automation delivered for the process/task?
If this is different to what you had expected then please explain the reason this has changed?

Guide: from what you say, it sounds like the level of automation might be classified as xxxx do you agree?

Business Process Task/Activity	Actual Level of Automation (1 to 5)	Reason for the decision and any difference to what was originally expected.

6) The following questions aim to understand what resources, activities and skills are still needed by workers to support the robot undertake the process/task

f) What resources are still needed to support the automated process/ task?
(*for instance staff effort, any engagement with governance groups, suppliers, details of the frequency/schedule to be followed to start and/or complete the task, finances*)
……

g) What activities still take place to support the automated process/ task?
(participant to *provide as much detailed information as they can, including what element of the duties are routine and what element requires judgement, including any specialist qualifications\accreditations required etc*):
……

h) What skills and knowledge are still required to support the automated process/task?
(*please provide detailed information, including what element is routine and what element requires judgement, including any specialist qualifications\accreditations required etc*):
……

7) During the Pre Automation Interview (Part B) feedback was provided about the expected output following the automation of the process/task. To what extent have the outputs been realised?
(*for instance robot undertaking agreed tasks; accurately; consistently; to an agreed quality*)
   i. The output is better than expected (5)
   ii. The output is in line with what was expected (3)
   iii. The output is worse than expected (1)
   iv. None of the above but provided other opportunities not expected (2)

Ask the participant to explain the reason for their decision:
……

8) During the Pre Automation Interview (Part B) feedback was provided about the expected outcome following the automation of the process/task. To what extent have the outcomes been realised?
(*for instance resources saved; time/effort saved; staff skills/experience; quality and quantity of the output; effort expectancy; direct and indirect benefits/consequences on you, your department/division and the organisation*)
    i. The outcome is better than expected (5)
    ii. The outcome is in line with what was expected (3)
    iii. The outcome is worse than expected (1)
    iv. None of the above but provided other opportunities not expected (2)

    Ask the participant to explain the reason for their decision:
    ………

9) During the Pre Automation Interview (Part B) feedback was provided about the potential issues, challenges and consequences following the automation of the process/task. To what extent have the intended impact been realised?
(*for instance intended and unintended changes on the organisation and on you and your role (e.g. job performance; job effectiveness); support to use the system and any assumptions you may have on the expected output and outcomes*)
    i. The impact is greater than expected (5)
    ii. The impact is in line with what was expected (3)
    iii. The impact is less than expected (1)
    iv. None of the above but provided other opportunities not expected (2)

    Ask the participant to explain the reason for their decision:
    ………

10) What has been the level of engagement with the RPA development team responsible for building the robots to discuss the process/task to be automated, information requested from you to build the automation and arrangements to transition to using the robot.
………

11) Reflecting back on the journey to automate the process/task and the present operational status of the automation, are there anything that you believe should have been undertaken differently, in terms of your engagement, the engagement with the RPA Development Team delivering the automation or the automation that was delivered. Y/N
If the response is Yes then ask the participant to provide details of these challenges:
………

12) In terms of the knowledge and skills for the business process/task that has been automated:

    a) Who will still possess the business knowledge about the process / task?

    b) Is there a timeframe (for instance: 3 months, 6 months; 9 months; 12 months) in the future when you believe you would potentially lose the knowledge/skills in order to manually perform the activity again?
    ____

        What is the reason for chosen the timeframe:

    c) What are the concerns or issues with retaining the knowledge and skills about the process/task going forward?

13) In Part B of the questionnaire you had specified the criteria on how you will be assessing or measuring whether the automation has delivered what you were expecting.
Has anything changed in terms of these criteria's now the automation is deployed? Y/N

If Yes, then ask the participant to explain what has changed and why
………

14) What would be your 2-3 key messages to any other organisation embarking on the process/task automation journey?

………

15) Do you have any additional information about the automation that you believe is relevant to the study that has not been captured in the previous questions?
………

Appendix A3 –Automation in Abeyance Interview Questions

Exploring the impact of workplace software "robot" process automation agents on the healthcare workforce.

Manager Staff -
Interview Schedule Questions
PART E - (AUTOMATION DELAYED/CANCELLED)

All responses are direct quotes provided by the participant unless indicated otherwise

SECTION - INTRODUCTION

5) Name of study participant(s): (a) …………………………………………………………………

(b) ………………………………………………………………………

6) Process planned for automated: ………………………………………………………………………………

7) Date of interview: …………/ …………… / …………….

SECTION – SOFTWARE ROBOT AUTOMATION DELAYED/ CANCELLED

Questions:
16) Please tell me the storey of why the process automation has not been implemented?
……

17) Has the automation been delayed, or cancelled or has something else happened?

i) Delayed *
ii) Cancelled *
iii) Other*: ………………………………………………………………………………………
* delete as appropriate

18) What are the reasons (for instance barriers, challenges, opportunities) that gave rise to the outcome you mentioned in question 2)?
……

19) What has the present situation meant for the process that you were looking to automated and has anything changed with the process?
……

20) What has the present situation meant for the workers performing the process, has anything changed for them?
……

21) Reflecting back on the journey to-date, are there anything you would have done differently in the approach you were taking or in the decisions made?
……

22) Is there anything else you wish to say that you believe may be helpful in understanding the reason why the process was not automated?
……

APPENDIX B – SELF ADMINISTERED QUESTIONNAIRE

Appendix B1 – Pre-Automation Questionnaires

Exploring the impact of workplace software "robot" process automation agents on the healthcare workforce.

Manager, Supervisor Staff –
Pro Forma Questionnaire
PART A - (PRE-AUTOMATION)

Objective: The objective of the research is to understand the impact of deploying software "robot" automation technologies that can mimic the actions performed by a human worker to undertake a process/task. This type of robot is known as a digital worker. The study aims to understand whether job roles and skill sets change as a result of digital workers. The study will be undertaken in two stages. The first stage is to understand the existing manual process that is performed and to understand the reason for automating it. The second stage will be undertaken several months after the automation has been bedded in, to understand what this has meant for the individual workers and the organisation.

All responses are direct quotes provided by the participant unless indicated otherwise

SECTION – INTRODUCTION

The purpose of this pro forma is to share a number of questions with you in advance of our meeting. This is to allow you time to collate the information requested. We can walk through your responses and any queries you may have at the interview.

The focus of these specific questions is to learn more about the process/ task, the people involved, the resources, skills and effort required.

	Participant 1	**Participant 2**	**Participant 3**
Your full name			
Do you have any previous knowledge and experience of automation and robotic technology (Yes or No)?			
) If Yes then please explain what experience you have?			
) Did you have a choice on whether to use the automation and robotic technology (Yes or No)?			
If "No", then please explain the reason for this			

12) What are your views on whether automation and robotic technology could be of benefit to <u>each participant</u> and your department?

....

13) The following questions aim to understand the people performing the manual process/task that will be automated:

   a) What is the Job role (or title) of the worker performing the process/task?

   ....

b) What qualifications (if any) would be required to be able to perform in the job role?
……….

c) Please describe the range of duties performed by the worker:
……

14) Date Completed: …………./ …………… / ……………..

SECTION – INFORMATION ABOUT THE MANUAL PROCESS/ TASK AND EFFORT INVOLVED
In this section I am interested to hear about the process/tasks that is presently performed manually and subject to being automated.

11) What is the name of the department the automation will be deployed in?
………………………………………………………………………………..

12) What is the name of the business process / task to be automated?
………………………………………………………………………………..

13) What are the reasons for choosing to automate the process / task, including any particular challenges presently being faced in performing the process/ task manually:
……….

14) This question is to understand how mature the existing process /task is, can you tell me whether this is:
   i. An existing established activity already being performed manually Y/N
   ii. An existing established activity that should be performed but time or resources are preventing it from being undertaken Y/N
   iii. A new business task that needs to be performed Y/N

15) The following questions aim to explore the existing manual effort, time and resources required to perform the process/ tasks before automation. Please complete each of the questions as fully as possible.

   i. How many times is the process/task performed per day? _______

   How much time (hours: minutes) is spent performing the task per day _______

   ii. How many times is the process/ task performed per week? _______

   How much time (hours: minutes) is spent performing the process /task per week _______

   iii. How many times is the process/task performed per month? _______

   How much time (hours: minutes) is spent performing the task per month _______

   iv. How many times is the process/ task performed per Year? _______

   How much time (hours: minutes) is spent performing the process/task per year _______

   v. How many workers are involved in performing the process/ task? _______

   vi. What is the NHS Payscale of the workers performing the process/task :

   ……….

vii. Are all the workers on the same NHS pay scale? Y/N

If the response is "No" then please state each of the NHS pay scale and the number of staff at each pay scale:

____

viii. Do you have any other relevant information about the time/effort involved in the process/task that has not been captured about ? (please specify)

____

Appendix B2 – Post-Automation Questionnaire

Exploring the impact of workplace software "robot" process automation agents on the healthcare workforce.

Manager/Supervisor/Operational Staff
Pro Forma Questionnaire
PART C - (POST-AUTOMATION)

Objective: Objective: The objective of the research is to understand the impact of deploying software "robot" automation technologies that can mimic the actions performed by a human worker to undertake a process/task. This type of robot is known as a digital worker. The study aims to understand whether job roles and skill sets change as a result of digital workers. The study will be undertaken in two stages. The first stage is to understand the existing manual process that is performed and to understand the reason for automating it. The second stage will be undertaken several months after the automation has been bedded in, to understand what this has meant for the individual workers and the organisation.

All responses are direct quotes provided by the participant unless indicated otherwise

SECTION – INTRODUCTION
The purpose of this pro forma is to share a number of questions with you in advance of our meeting. This is to allow you time to collate the information requested. We can walk through your responses and any queries you may have at the interview.

The focus of these specific questions is to learn more about what has changed following the deployment of the software automation and to assess whether any human worker is still involved in supporting/undertaking the task, as well as understand the resources, the skills and effort still involved.

15) Name of study participant(s): (a) ………………………………………………………………………

(b) ………………………………………………………………………

2) Date Completed: …………/ …………… / ……………..

SECTION – INFORMATION ABOUT THE AUTOMATED PROCESS/TASK AND EFFORT INVOLVED
In this section I am interested in understanding about the process/tasks that has been automated and what this means to you in supporting the robot.

16) Who has been directly affected by the automation ?
(*please select Yes or No. If you have said Yes then please enter the number of staff affected*) :

Who has been affected by automation	Impacted?	Number of staff affected
An individual worker	Yes / No	-
The team performing the task	Yes / No	
The department	Yes / No	
The organisation	Yes / No	
Other (Please specify who else has been affected --	Yes / No	

17) To what extent do you agree with the following statement regarding what is now delivered by the automation (robot):

Guidance: Please select a response from the following Likert scale. In addition, specify the reason for your choice.

Likert Scale: ***1*** *= Strongly Disagree;*
2 *= Disagree;*
3 *= Neither Agree nor Disagree;*
4 *= Agree;*
5 *= Strongly Agree*

#	**Statement**	**Response** (1 to 5)	**Reason for your response** (please provide as much information as possible against each statement)
A	The automation is useful in my job		
B	The automation allows me to do my job more quickly than before		
C	The automation has helped to do my job more accurately than before		
D	The automation has allowed me to save time to focus on other duties		
E	The automation provides me with accurate and consistent information every time		
F	The automation has allowed me to make better use of my skills		
G	I am comfortable working with the automation		
H	Learning what I could do with the automation was easy for me		
I	Interacting with the automation is easy		
J	Setting up the automation to correctly undertake the process/task was easy		
K	I trust the automation to complete its activities correctly every time		
L	I trust the automation to tell me when it is having issues in completing the process / task		
M	I know who to contact if the automation stopped working or if I noticed an issue		
N	I am confident someone in my department will know if the automation is not completing its tasks correctly		
O	If the automation stopped working and could not continue then we still have the resources in the team to perform the process/task manually		
P	If the automation stopped working and could not continue then we still have the knowledge and skills to perform the process/task manually		
Q	Using the automation takes too much time and effort away from performing my normal duties		
R	I have the necessary resources (training, procedure, guidance) to enable me to understand and work with the automation		

#	Statement	Response (1 to 5)	Reason for your response (please provide as much information as possible against each statement)
S	A specific person is available to provide me with assistance when there are difficulties with the automation		
T	I have to always use the automation to undertake the process/task		
U	My job role has changed because of the tasks now performed by the automation		
V	My skills have changed because of the tasks now performed by the automation		
W	I can look for new opportunities in the organisation because the process/task is now performed by the automation		

18) The following questions aim to explore the manual effort, time and resources still required to support the process/ tasks now that it has been automated. Please complete each of the questions as fully as possible.

i. How many times is the process/task performed per day? ________

How much time (hours: minutes) is spent performing the task per day ________

ii. How many times is the process/ task performed per week? ________

How much time (hours: minutes) is spent performing the process /task per week ________

iii. How many times is the process/task performed per month? ________

How much time (hours: minutes) is spent performing the task per month ________

iv. How many times is the process/ task performed per Year? ________

How much time (hours: minutes) is spent performing the process/task per year ________

v. How many workers are involved in performing the process/ task? ________

vi. What is the NHS Payscale of the workers performing the process/task :

……

vii. Are all the workers on the same NHS pay scale? Y/N

If the response is "No" then please state each of the NHS pay scale and the number of staff at each pay scale:

viii. Do you have any other relevant information about the time/effort involved in the process/task that has not been captured about ? (please specify)

____

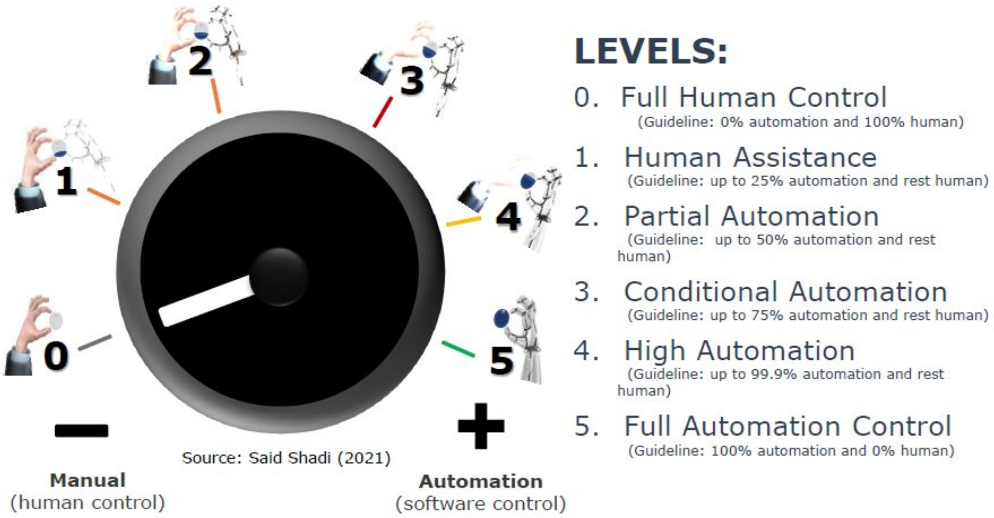
APPENDIX C – LEVELS OF AUTOMATION

C1. Original levels of automation (levels 1 to 8):

Level of autonomy	Stage Category	Description
1	Full Manual Control	No automation agent. Human worker does everything
2	Manual Assistance – Supervised	The automation agent cannot perform any action by itself and requires a human worker to initiate the robot activities. The automation agent activities are supervised by the human worker at all times. All issues and incidents from the automation agent actions and the completion of the next task in the process chain are managed by the human worker.
3	Manual Assistance – Assisted	The automation agent cannot perform any action by itself and requires a human worker to initiate the robot activities. The automation agent activities are not supervised by the human worker. A human worker only intervenes when the automation agent has completed its tasks or a decision is required by the human worker or if there is an issue or incident that requires intervention.
4	Semi-Automated Execution - Assisted	The automation agent decides when it performs an activity (typically based on a calendar schedule or another trigger event). A human worker only intervenes when the automation agent has completed its tasks or a decision is required by the human worker or if an error occurs by the automation agent – expected or unexpected error.
5	Semi-Automated Execution – Adaptive Advisor	The automation agent decides when it performs an activity (typically based on a calendar schedule or another trigger event). The automation agent uses structured data provided by the human worker and makes all relevant rule based decisions. A human worker only intervenes if an error occurs by the automation agent – expected or unexpected error.
6	Semi-Automated Execution - Simple Aid	The automation agent decides when it performs an activity (typically based on a calendar schedule or another trigger event). The automation agent uses structured data, formats the data required and makes all relevant rule based decisions. The automation agent takes care of all expected errors. A human worker only intervenes if an error occurs that the automation agent is not expecting.
7	Automated execution – Augmented Intelligence	The automation agent decides when it performs an activity (typically based on a calendar schedule or another trigger event). The automation agent uses structured, semi-structured and unstructured data and makes all necessary rule based decisions and uses augmented intelligence. The automation agent takes care of all expected errors. A human worker only intervenes if an error occurs that the automation agent is not expecting.
8	Fully Automation – Autonomous Intelligence	The automation agent does everything without human worker intervention. The automation agent takes care of all data structures and can take care of all expected and unexpected errors.

Source: Adapted from Vagia et al. (2016)

C2. Revised levels of automation (levels 0 to 5) model:



Level of Autonomy	Stage Category	Description
0	**Full Human Control**	No automation agent. The human does everything manually Guidance: 100% human and 0% Automation
1	**Human Assistance**	The human worker is still in charge and initiates when the automation agent performs its task and when it stops. The human remains in full control to supervise the automation agent activities and make any decisions required and can take over when any issues arises Note: At this level the Human has full responsibility to monitor the situation and take control if the automation agent assistance cannot do so for any reason. The automation agent may have its own or use your security credentials to access the relevant systems. Guidance: up to 25% performed by Automation, the rest by Human activity
2	**Partial Automation**	The automation agent performs an activity based on a calendar schedule or another trigger event (for instance a relevant file existing in a folder or when instructed). The automation agent only uses well-defined and well formatted data (known as structured data) to make many rule-based decisions. The automation agent passes control back to a human worker when it is not sure how to navigate a scenario it does not know about, or where certain decisions (for instance authorisation or login credentials) need to be made or if any other unexpected situation arises. Note: At this level a human is required to still monitor the automation agent and provide assistance. This includes formatting the structured data that the automation agent will use. The automation agent will typically have its own security credentials. Guidance: up to 50% performed by Automation, the rest by Human activity
3	**Conditional Automation**	The automation agent decides when to perform an activity (for instance based on a calendar schedule or another trigger event). The automation agent can use structured data and semi-structured data (for instance the data being partially formatted) to assess the situation and make all relevant rule-based decisions. The automation agent passes

		control back to a human worker when it is not sure how to navigate a scenario it does not know about or if any other unexpected situation arises. Note: At this level the human only has to intervene when the automation agent is not able to handle a situation (automation agent not already trained to handle) and requires a human worker to take control of the situation or to review the outcomes from the activities performed by the automation agent. This includes formatting the semi-structured data that the automation agent will use. The automation agent will have its own security credentials. Guidance: up to 75% performed by Automation, the rest by Human activity
4	**High Automation**	The automation agent decides when to perform an activity (for instance based on a calendar schedule or another trigger event). The automation agent uses structured data, semi-structured data and unstructured data (for instance PDF, images, videos, email contents) to assess the situation and make all relevant decisions and taking care of all expected errors. The automation agent only passes control back to a human worker only when an unexpected situation arises. Minimum human intervention being achieved. Guidance: up to 99.9% performed by Automation, the rest by Human activity
5	**Full Automation Control**	The automation agent does everything without any human worker intervention. The automation agent takes care of all data structure types and all expected and unexpected situations. Note: At this level, no human intervention is required although there may be human monitoring and supervision of the automation agents. Guidance: 0% Human activity and 100% Automation

Source: Said Shadi (2021)

APPENDIX D – PARTICIPANT CONSENT FORM

Exploring the impact of workplace software "robotic" process automation agents on the healthcare workforce.

Consent Form

I have been provided with information about the research project by Said Shadi (the researcher). I have read the Information Sheet concerning the study and understand what it is about. Any questions I had have been answered to my satisfaction. I understand that I am free to request further information at any stage by contacting Said Shadi who details are provided at the bottom of this form. All participant details will be anonymised and remain confidential.

I know that: *(please initial each box)*

1. My participation in the study is entirely voluntary. ☐
2. I am free to withdraw from the study at any time without any disadvantage. ☐
3. If an audio recording is made (with the consent of the participant), it will be kept in accordance with research governance policies and any raw data on which the results of the study depend will be retained in secure storage. The recordings and transcripts created will be shared with the participant. ☐
4. I have the right to decline to answer particular question(s). ☐
5. My participation should not lead to any potential harm or discomfort. ☐
6. The results of the study may be published and used for educational purposes but my anonymity will be preserved. ☐
7. I agree to take part in this study. ☐

Participant:

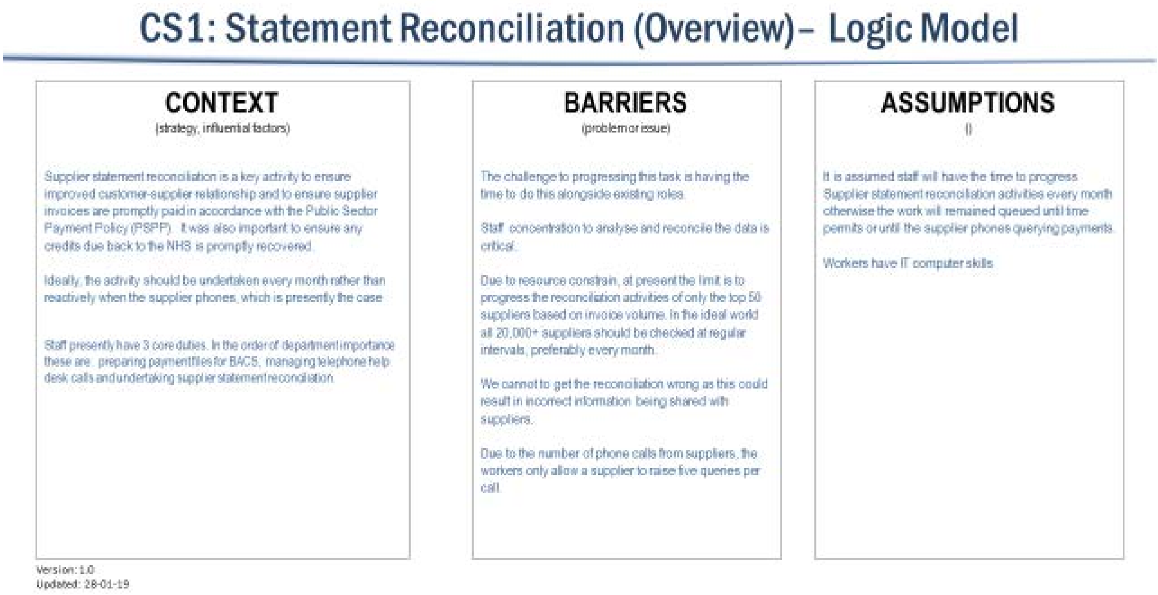
Name: ___________________________ Signed: _________________________ Date: ____________

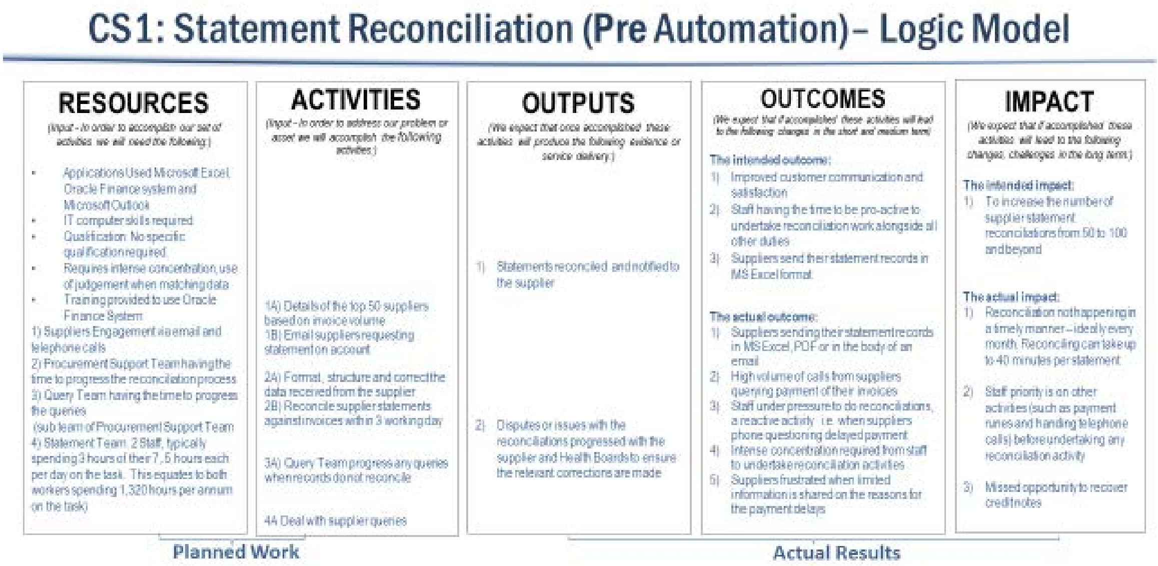
Researcher:

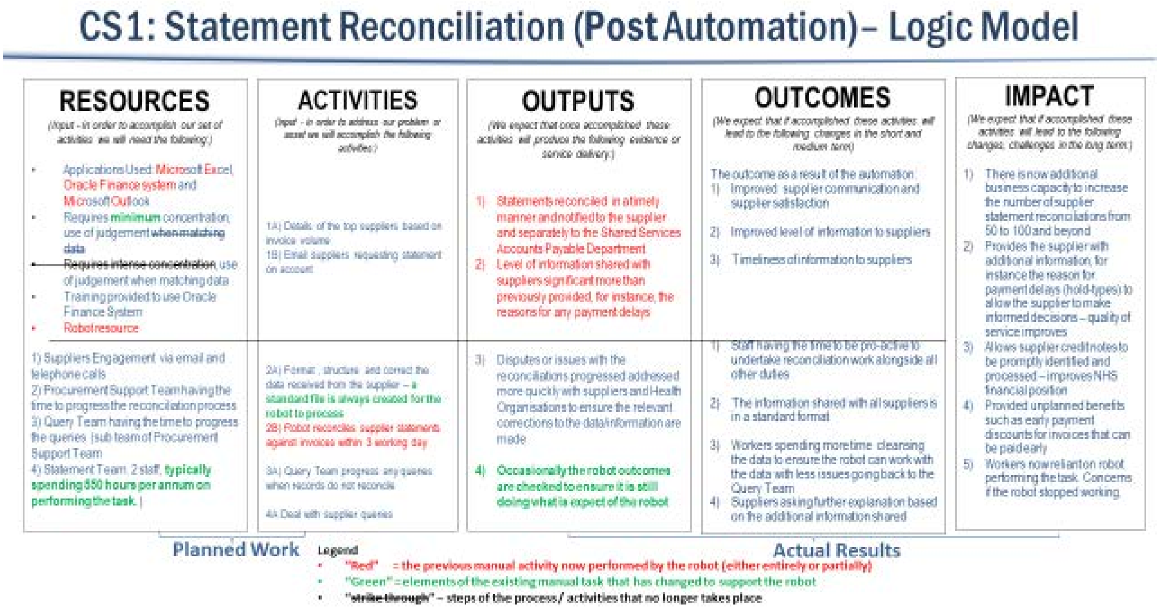
Name: ___________________________ Signed: _________________________ Date: ____________

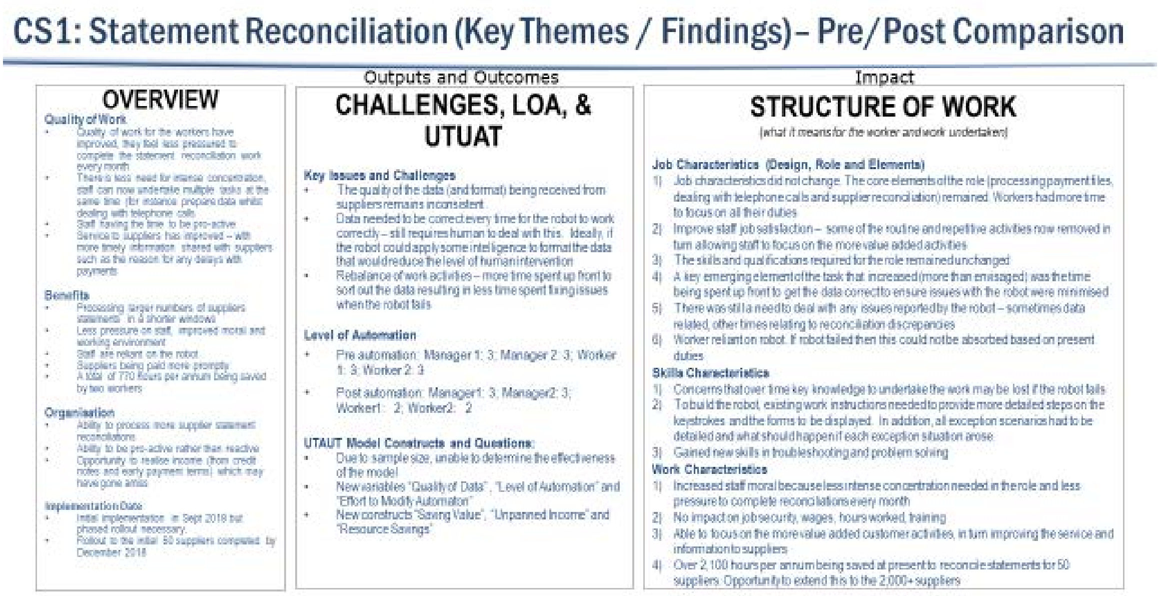
APPENDIX E – CASE STUDY LOGIC MODEL ANALYSIS

Case Study 1 - Statement

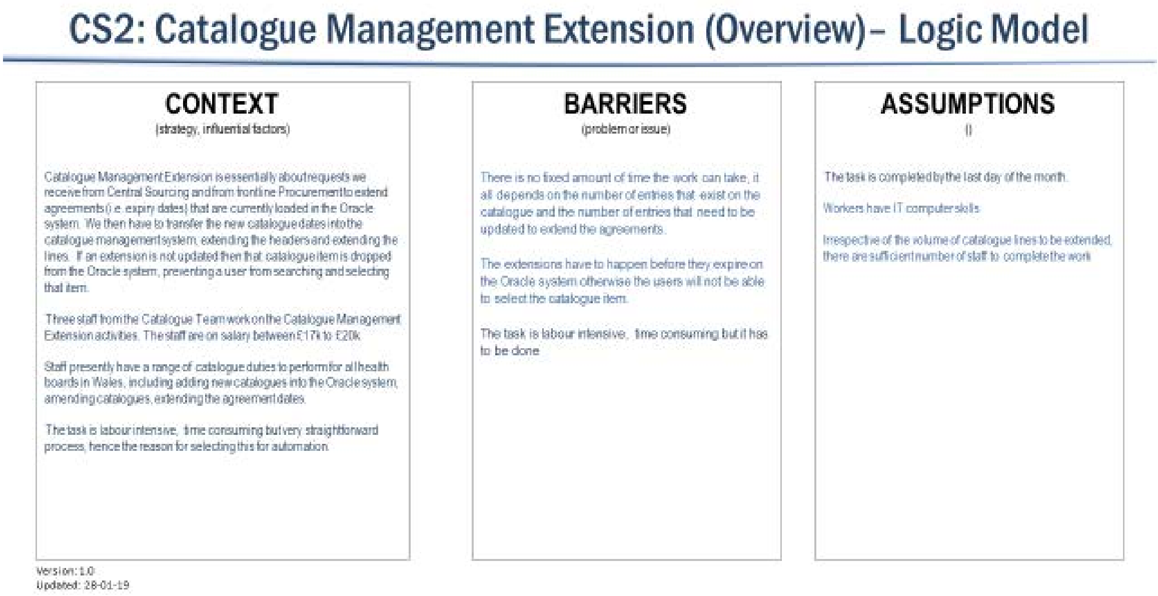


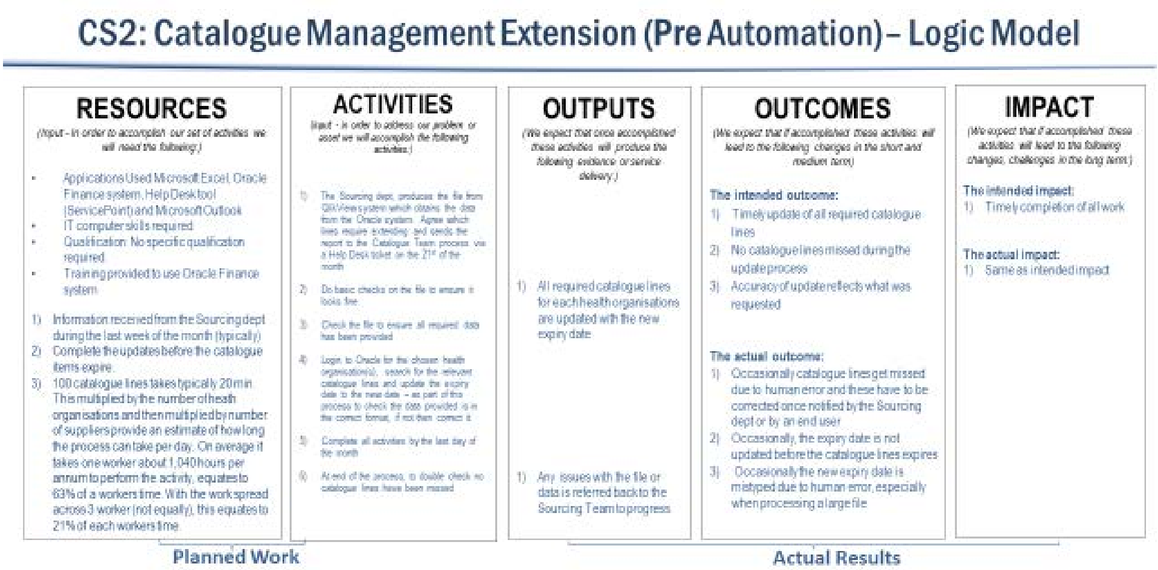


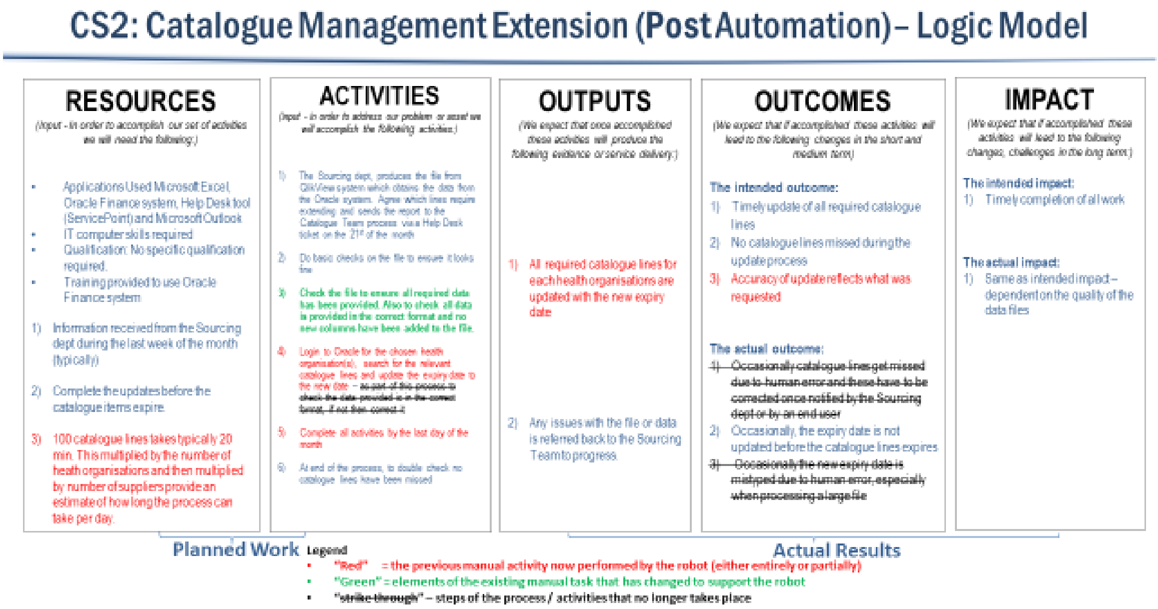

CS1: Statement Reconciliation (Post Automation)– Logic Model
RESOURCES
(Input - in order to accomplish our set of activities we will need the following:)
Applications Used: Microsoft Excel, Oracle Finance system and Microsoft Outlook
Requires minimum concentration, use of judgement when matching data
Requires intense concentration, use of judgement when matching data
Training provided to use Oracle Finance System
Robot resource
1) Suppliers Engagement via email and telephone calls
2) Procurement Support Team having the time to progress the reconciliation process
3) Query Team having the time to progress the queries (sub team of Procurement Support Team
4) Statement Team: 2 staff, typically spending 550 hours per annum on performing the task.)
ACTIVITIES
(Input - in order to address our problem or asset we will accomplish the following activities:)
1A) Details of the top suppliers based on invoice volume
1B) Email suppliers requesting statement on account
2A) Format, structure and correct the data received from the supplier – a standard file is always created for the robot to process
2B) Robot reconciles supplier statements against invoices within 3 working day
3A) Query Team progress any queries when records do not reconcile
4A Deal with supplier queries
OUTPUTS
(We expect that once accomplished these activities will produce the following evidence or service delivery:)
1) Statements reconciled in a timely manner and notified to the supplier and separately to the Shared Services Accounts Payable Department
2) Level of information shared with suppliers significant more than previously provided, for instance, the reasons for any payment delays
3) Disputes or issues with the reconciliations progressed addressed more quickly with suppliers and Health Organisations to ensure the relevant corrections to the data/information are made
4) Occasionally the robot outcomes are checked to ensure it is still doing what is expect of the robot
OUTCOMES
(We expect that if accomplished these activities will lead to the following changes in the short and medium term)
The outcome as a result of the automation:
1) Improved supplier communication and supplier satisfaction
2) Improved level of information to suppliers
3) Timeliness of information to suppliers
1) Staff having the time to be pro-active to undertake reconciliation work alongside all other duties
2) The information shared with all suppliers is in a standard format
3) Workers spending more time cleansing the data to ensure the robot can work with the data with less issues going back to the Query Team
4) Suppliers asking further explanation based on the additional information shared
IMPACT
(We expect that if accomplished these activities will lead to the following changes, challenges in the long term.)
1) There is now additional business capacity to increase the number of supplier statement reconciliations from 50 to 100 and beyond
2) Provides the supplier with additional information, for instance the reason for payment delays (hold-types) to allow the supplier to make informed decisions – quality of service improves
3) Allows supplier credit notes to be promptly identified and processed – improves NHS financial position
4) Provided unplanned benefits such as early payment discounts for invoices that can be paid early
5) Workers now reliant on robot performing the task. Concerns if the robot stopped working
Planned Work
Actual Results
Legend
"Red" = the previous manual activity now performed by the robot (either entirely or partially)
"Green" = elements of the existing manual task that has changed to support the robot
"strike through" – steps of the process / activities that no longer takes place

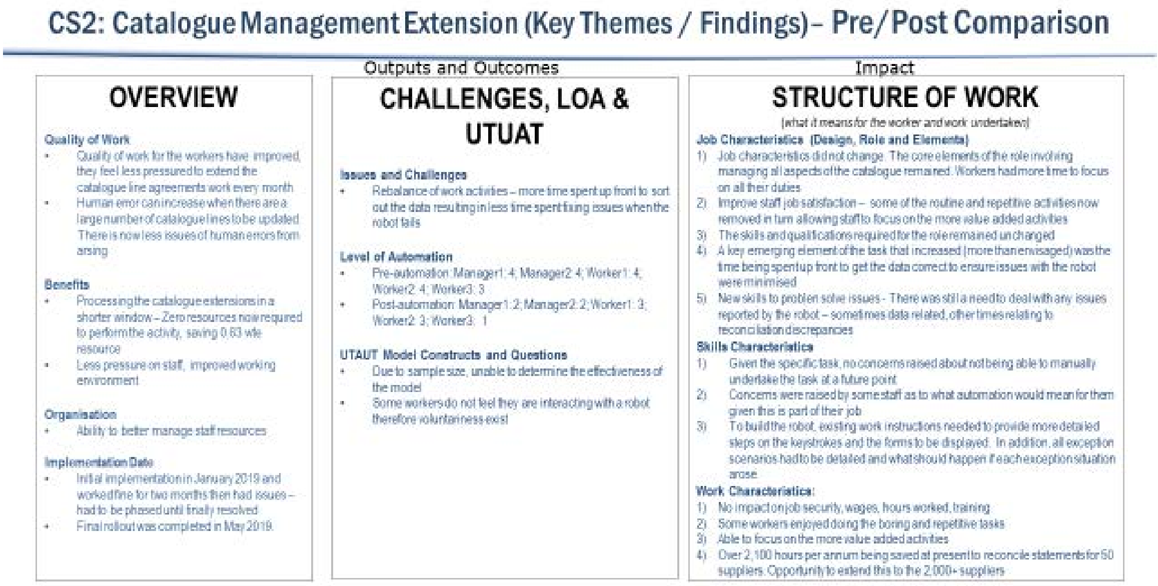

CS1: Statement Reconciliation (Key Themes / Findings)– Pre/Post Comparison
OVERVIEW
Quality of Work
Quality of work for the workers have improved, they feel less pressured to complete the statement reconciliation work every month
There is less need for intense concentration, staff can now undertake multiple tasks at the same time (for instance prepare data whilst dealing with telephone calls
Staff having the time to be pro-active
Service to suppliers has improved – with more timely information shared with suppliers such as the reason for any delays with payments
Benefits
Processing larger numbers of suppliers statements in a shorter windows
Less pressure on staff, improved moral and working environment
Staff are reliant on the robot
Suppliers being paid more promptly
A total of 770 hours per annum being saved by two workers
Organisation
Ability to process more supplier statement reconciliations
Ability to be pro-active rather than reactive
Opportunity to realise income (from credit notes and early payment terms) which may have gone amiss
Implementation Date
Initial implementation in Sept 2018 but phased rollout necessary.
Rollout to the initial 50 suppliers completed by December 2018
Outputs and Outcomes
CHALLENGES, LOA, & UTUAT
Key Issues and Challenges
The quality of the data (and format) being received from suppliers remains inconsistent
Data needed to be correct every time for the robot to work correctly – still requires human to deal with this. Ideally, if the robot could apply some intelligence to format the data that would reduce the level of human intervention
Rebalance of work activities – more time spent up front to sort out the data resulting in less time spent fixing issues when the robot fails
Level of Automation
Pre automation: Manager 1: 3; Manager 2: 3; Worker 1: 3; Worker 2: 3
Post automation: Manager1: 3; Manager2: 3; Worker1: 2; Worker2: 2
UTAUT Model Constructs and Questions:
Due to sample size, unable to determine the effectiveness of the model
New variables "Quality of Data", "Level of Automation" and "Effort to Modify Automation"
New constructs "Saving Value", "Unpanned Income" and "Resource Savings"
Impact
STRUCTURE OF WORK
(what it means for the worker and work undertaken)
Job Characteristics (Design, Role and Elements)
1) Job characteristics did not change. The core elements of the role (processing payment files, dealing with telephone calls and supplier reconciliation) remained. Workers had more time to focus on all their duties
2) Improve staff job satisfaction – some of the routine and repetitive activities now removed in turn allowing staff to focus on the more value added activities
3) The skills and qualifications required for the role remained unchanged
4) A key emerging element of the task that increased (more than envisaged) was the time being spent up front to get the data correct to ensure issues with the robot were minimised
5) There was still a need to deal with any issues reported by the robot – sometimes data related, other times relating to reconciliation discrepancies
6) Worker reliant on robot. If robot failed then this could not be absorbed based on present duties
Skills Characteristics
1) Concerns that over time key knowledge to undertake the work may be lost if the robot fails
2) To build the robot, existing work instructions needed to provide more detailed steps on the keystrokes and the forms to be displayed. In addition, all exception scenarios had to be detailed and what should happen if each exception situation arose
3) Gained new skills in troubleshooting and problem solving
Work Characteristics
1) Increased staff moral because less intense concentration needed in the role and less pressure to complete reconciliations every month
2) No impact on job security, wages, hours worked, training
3) Able to focus on the more value added customer activities, in turn improving the service and information to suppliers
4) Over 2,100 hours per annum being saved at present to reconcile statements for 50 suppliers. Opportunity to extend this to the 2,000+ suppliers

Case Study 2 - Catalogue

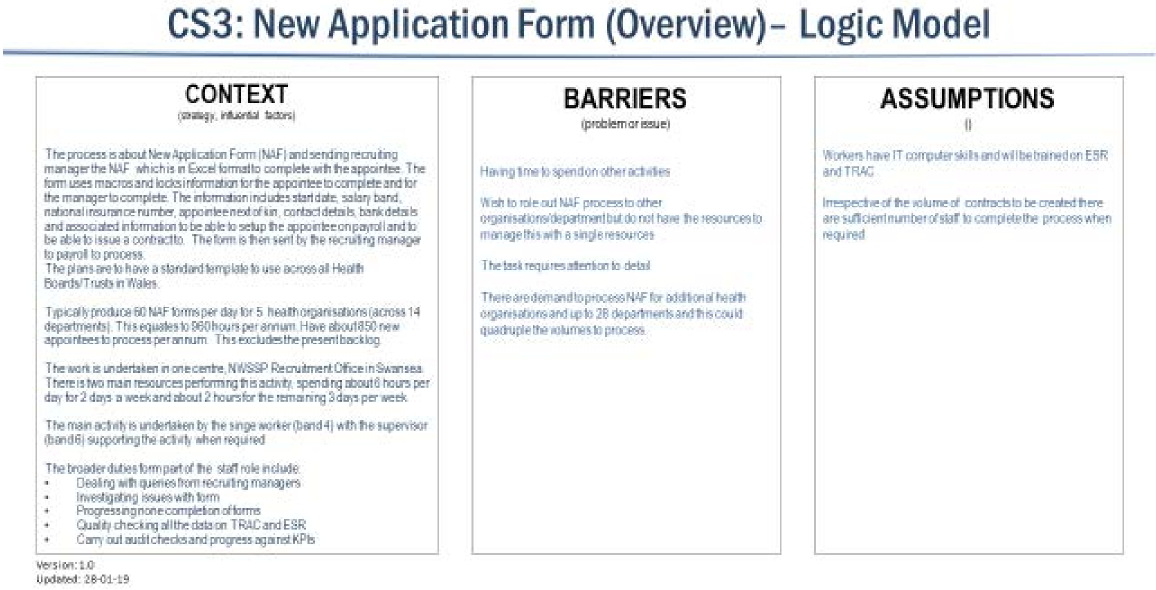


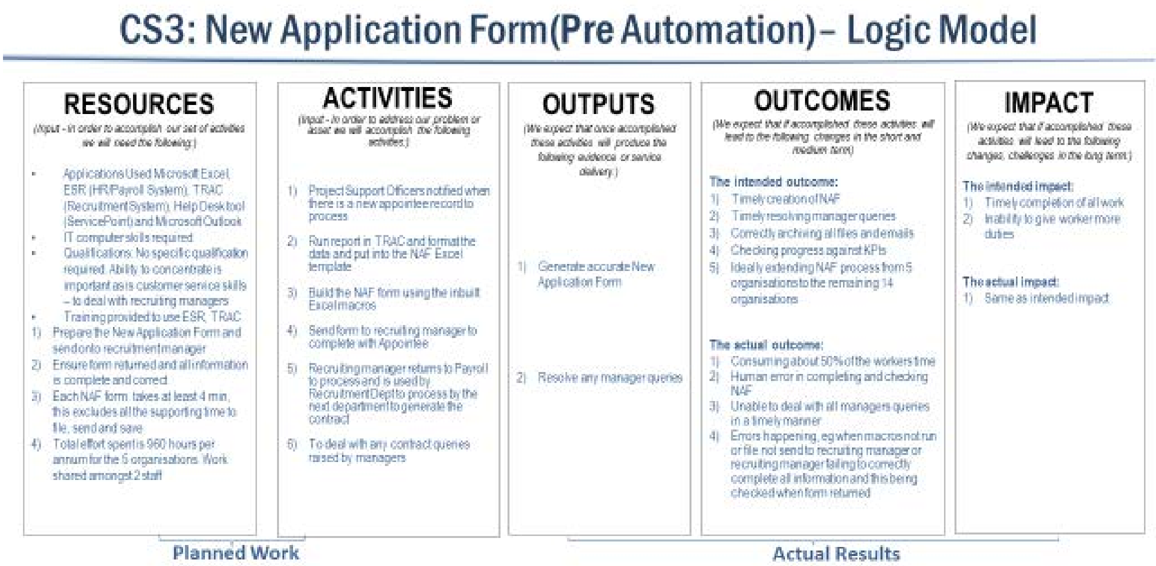


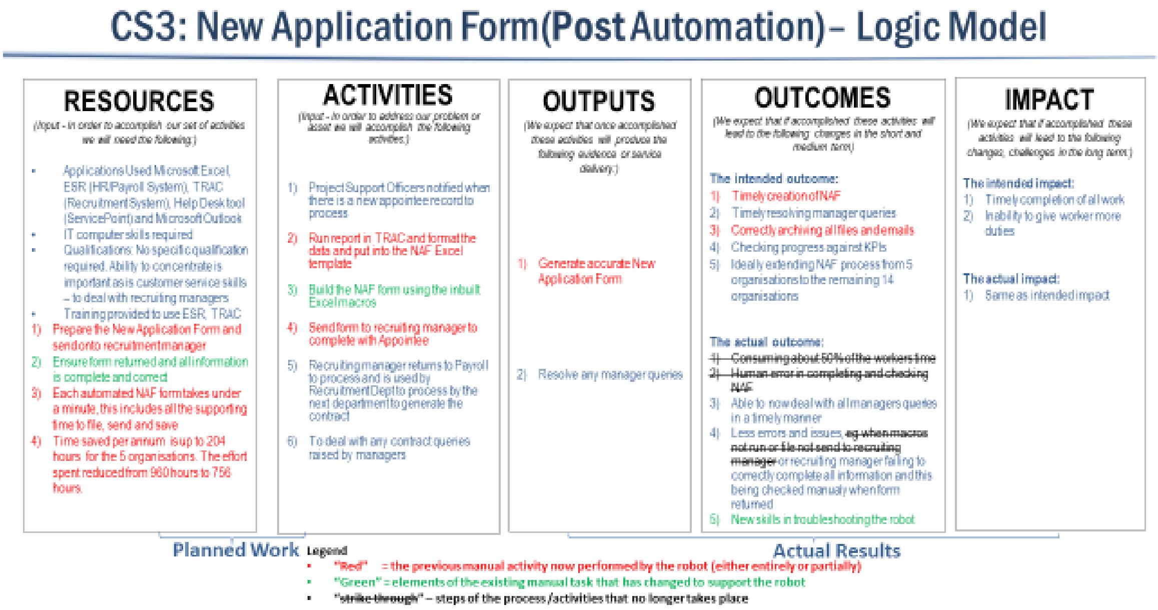

CS2: Catalogue Management Extension (Post Automation) – Logic Model
RESOURCES
(Input - In order to accomplish our set of activities we will need the following:)
• Applications Used Microsoft Excel, Oracle Finance system, Help Desk tool (ServicePoint) and Microsoft Outlook
• IT computer skills required
• Qualification: No specific qualification required.
• Training provided to use Oracle Finance system
1) Information received from the Sourcing dept during the last week of the month (typically)
2) Complete the updates before the catalogue items expire.
3) 100 catalogue lines takes typically 20 min. This multiplied by the number of heath organisations and then multiplied by number of suppliers provide an estimate of how long the process can take per day.
ACTIVITIES
(Input - In order to address our problem or asset we will accomplish the following activities:)
1) The Sourcing dept, produces the file from QlikView system which obtains the data from the Oracle system. Agree which lines require extending and sends the report to the Catalogue Team process via a Help Desk ticket on the 21st of the month
2) Do basic checks on the file to ensure it looks fine
3) Check the file to ensure all required data has been provided. Also to check all data is provided in the correct format and no new columns have been added to the file.
4) Login to Oracle for the chosen health organisation(s), search for the relevant catalogue lines and update the expiry date to the new date – ~~as part of this process to check the data provided is in the correct format, if not then correct it~~
5) Complete all activities by the last day of the month
6) At end of the process, to double check no catalogue lines have been missed
OUTPUTS
(We expect that once accomplished these activities will produce the following evidence or service delivery:)
1) All required catalogue lines for each health organisations are updated with the new expiry date
2) Any issues with the file or data is referred back to the Sourcing Team to progress.
OUTCOMES
(We expect that if accomplished these activities will lead to the following changes in the short and medium term)
The intended outcome:
1) Timely update of all required catalogue lines
2) No catalogue lines missed during the update process
3) Accuracy of update reflects what was requested
The actual outcome:
~~1) Occasionally catalogue lines get missed due to human error and these have to be corrected once notified by the Sourcing dept or by an end user~~
2) Occasionally, the expiry date is not updated before the catalogue lines expires
~~3) Occasionally the new expiry date is mistyped due to human error, especially when processing a large file~~
IMPACT
(We expect that if accomplished these activities will lead to the following changes, challenges in the long term.)
The intended impact:
1) Timely completion of all work
The actual impact:
1) Same as intended impact – dependent on the quality of the data files
Planned Work
Actual Results
Legend
• "Red" = the previous manual activity now performed by the robot (either entirely or partially)
• "Green" = elements of the existing manual task that has changed to support the robot
• "~~strike-through~~" – steps of the process / activities that no longer takes place

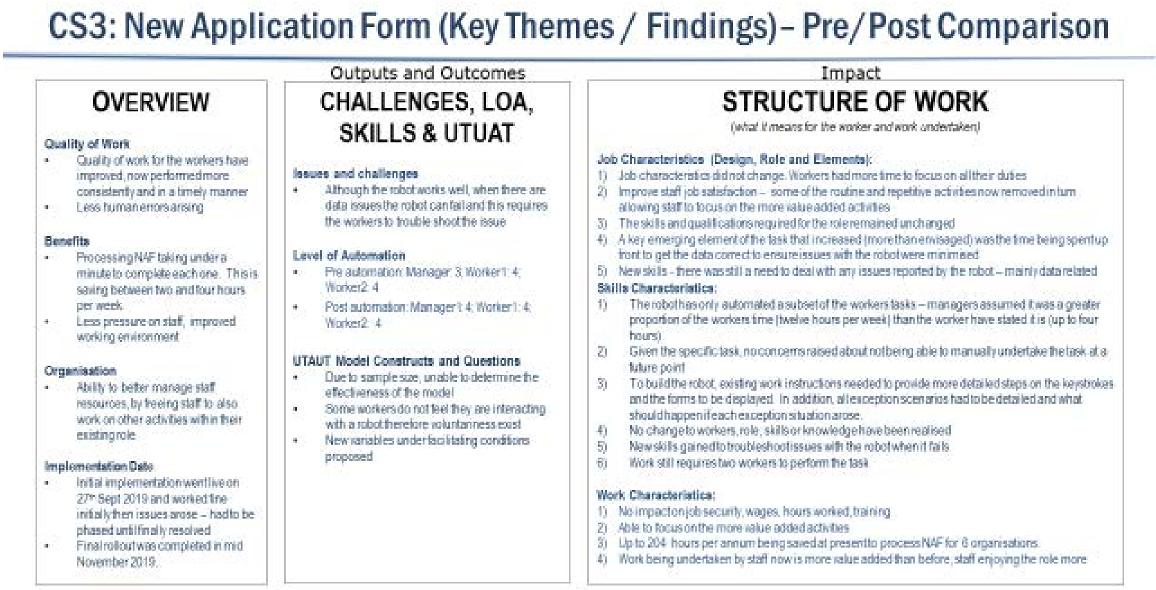

CS2: Catalogue Management Extension (Key Themes / Findings) – Pre/Post Comparison
OVERVIEW
Quality of Work
• Quality of work for the workers have improved, they feel less pressured to extend the catalogue line agreements work every month
• Human error can increase when there are a large number of catalogue lines to be updated. There is now less issues of human errors from arising
Benefits
• Processing the catalogue extensions in a shorter window – Zero resources now required to perform the activity, saving 0.63 wte resource
• Less pressure on staff, improved working environment
Organisation
• Ability to better manage staff resources
Implementation Date
• Initial implementation in January 2019 and worked fine for two months then had issues – had to be phased until finally resolved
• Final rollout was completed in May 2019.
Outputs and Outcomes
CHALLENGES, LOA & UTUAT
Issues and Challenges
• Rebalance of work activities – more time spent up front to sort out the data resulting in less time spent fixing issues when the robot fails
Level of Automation
• Pre-automation: Manager1: 4; Manager2: 4; Worker1: 4; Worker2: 4; Worker3: 3
• Post-automation: Manager1: 2; Manager2: 2; Worker1: 3; Worker2: 3; Worker3: 1
UTAUT Model Constructs and Questions
• Due to sample size, unable to determine the effectiveness of the model
• Some workers do not feel they are interacting with a robot therefore voluntariness exist
Impact
STRUCTURE OF WORK
(what it means for the worker and work undertaken)
Job Characteristics (Design, Role and Elements)
1) Job characteristics did not change. The core elements of the role involving managing all aspects of the catalogue remained. Workers had more time to focus on all their duties
2) Improve staff job satisfaction – some of the routine and repetitive activities now removed in turn allowing staff to focus on the more value added activities
3) The skills and qualifications required for the role remained unchanged
4) A key emerging element of the task that increased (more than envisaged) was the time being spent up front to get the data correct to ensure issues with the robot were minimised
5) New skills to problem solve issues - There was still a need to deal with any issues reported by the robot – sometimes data related, other times relating to reconciliation discrepancies
Skills Characteristics
1) Given the specific task, no concerns raised about not being able to manually undertake the task at a future point
2) Concerns were raised by some staff as to what automation would mean for them given this is part of their job
3) To build the robot, existing work instructions needed to provide more detailed steps on the keystrokes and the forms to be displayed. In addition, all exception scenarios had to be detailed and what should happen if each exception situation arose.
Work Characteristics:
1) No impact on job security, wages, hours worked, training
2) Some workers enjoyed doing the boring and repetitive tasks
3) Able to focus on the more value added activities
4) Over 2,100 hours per annum being saved at present to reconcile statements for 50 suppliers. Opportunity to extend this to the 2,000+ suppliers

Case Study 3 - Appointment:

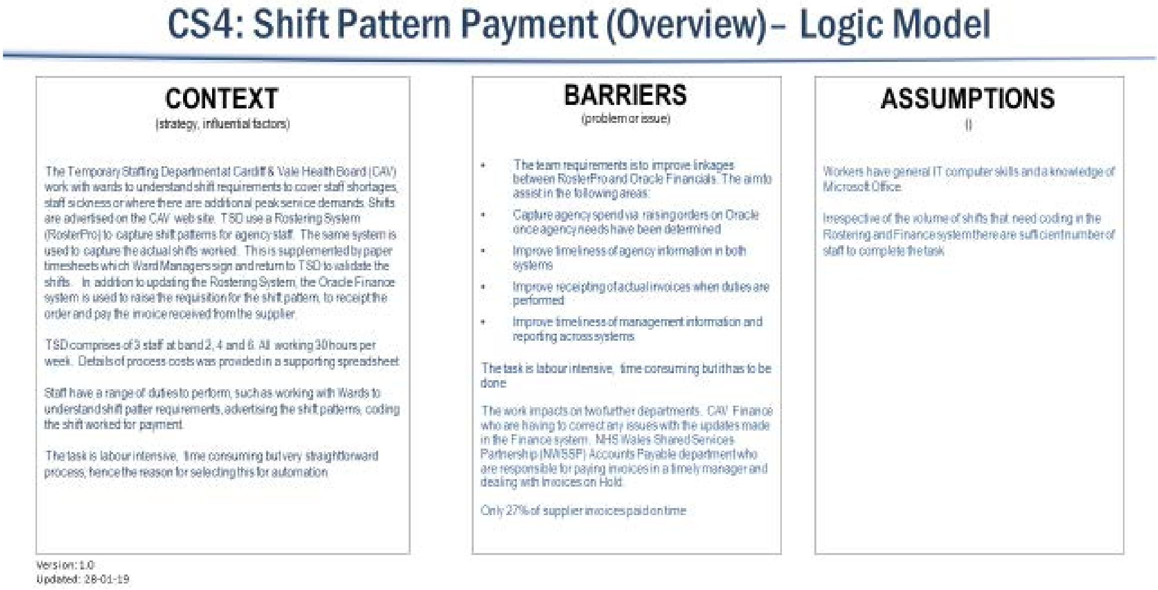


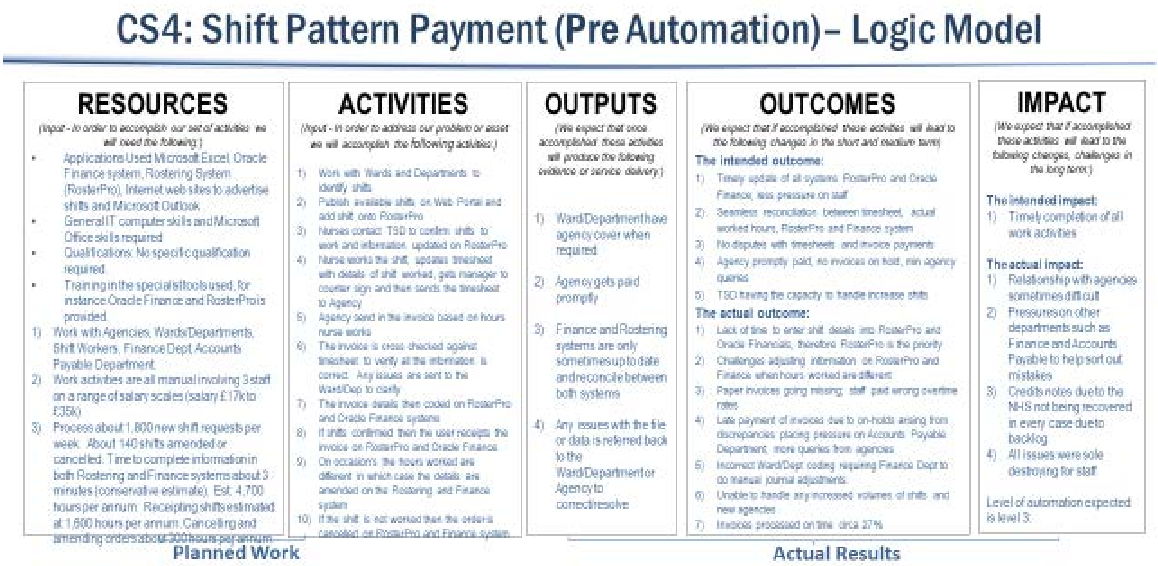


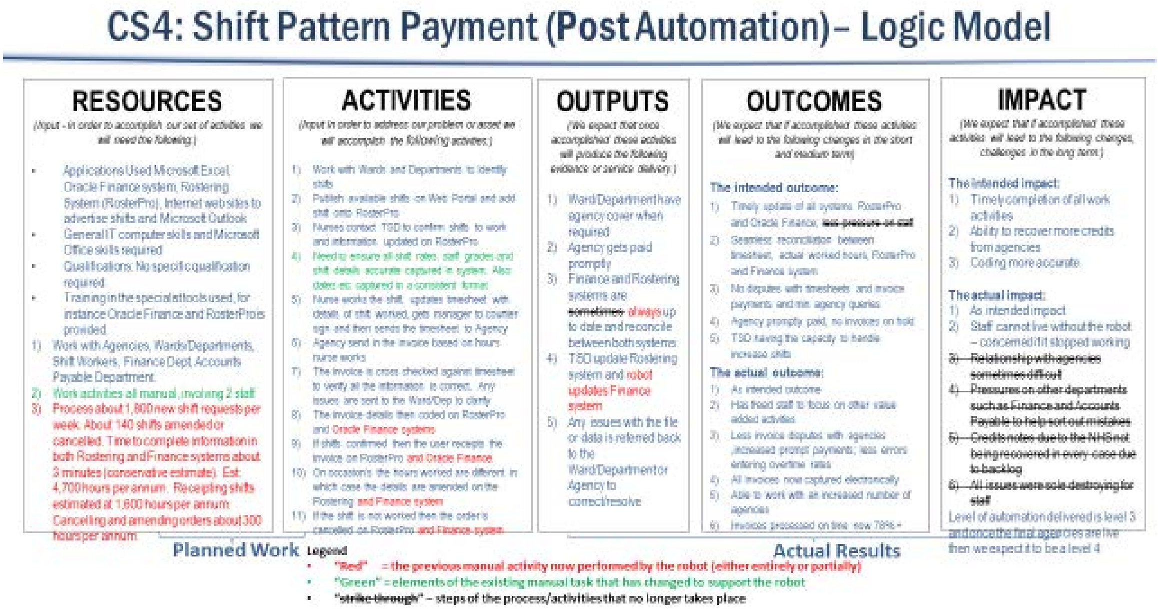

CS3: New Application Form(Post Automation)– Logic Model
RESOURCES
(Input - In order to accomplish our set of activities we will need the following:)
• Applications Used Microsoft Excel, ESR (HR/Payroll System), TRAC (Recruitment System), Help Desk tool (ServicePoint) and Microsoft Outlook
• IT computer skills required
• Qualifications: No specific qualification required. Ability to concentrate is important as is customer service skills – to deal with recruiting managers
• Training provided to use ESR, TRAC
1) Prepare the New Application Form and send onto recruitment manager
2) Ensure form returned and all information is complete and correct
3) Each automated NAF form takes under a minute, this includes all the supporting time to file, send and save
4) Time saved per annum is up to 204 hours for the 5 organisations. The effort spent reduced from 960 hours to 756 hours.
ACTIVITIES
(Input - In order to address our problem or asset we will accomplish the following activities:)
1) Project Support Officers notified when there is a new appointee record to process
2) Run report in TRAC and format the data and put into the NAF Excel template
3) Build the NAF form using the inbuilt Excel macros
4) Send form to recruiting manager to complete with Appointee
5) Recruiting manager returns to Payroll to process and is used by Recruitment Dept to process by the next department to generate the contract
6) To deal with any contract queries raised by managers
OUTPUTS
(We expect that once accomplished these activities will produce the following evidence or service delivery:)
1) Generate accurate New Application Form
2) Resolve any manager queries
OUTCOMES
(We expect that if accomplished these activities will lead to the following changes in the short and medium term)
The intended outcome:
1) Timely creation of NAF
2) Timely resolving manager queries
3) Correctly archiving all files and emails
4) Checking progress against KPIs
5) Ideally extending NAF process from 5 organisations to the remaining 14 organisations
The actual outcome:
~~1) Consuming about 50% of the workers time~~
~~2) Human error in completing and checking NAF~~
3) Able to now deal with all managers queries in a timely manner
4) Less errors and issues, ~~eg when macros not run or file not send to recruiting manager~~ or recruiting manager failing to correctly complete all information and this being checked manually when form returned
5) New skills in troubleshooting the robot
IMPACT
(We expect that if accomplished these activities will lead to the following changes, challenges in the long term.)
The intended impact:
1) Timely completion of all work
2) Inability to give worker more duties
The actual impact:
1) Same as intended impact
Planned Work
Actual Results
Legend
• "Red" = the previous manual activity now performed by the robot (either entirely or partially)
• "Green" = elements of the existing manual task that has changed to support the robot
• "~~strike through~~" – steps of the process /activities that no longer takes place

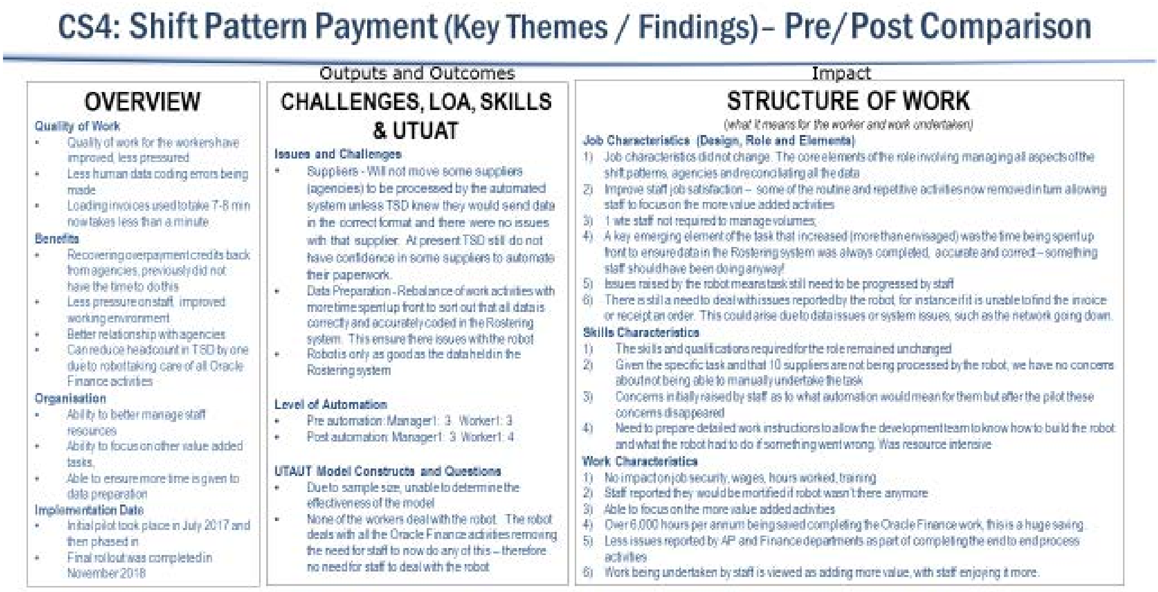

CS3: New Application Form (Key Themes / Findings)– Pre/Post Comparison
OVERVIEW
Quality of Work
• Quality of work for the workers have improved, now performed more consistently and in a timely manner
• Less human errors arising
Benefits
• Processing NAF taking under a minute to complete each one. This is saving between two and four hours per week.
• Less pressure on staff; improved working environment
Organisation
• Ability to better manage staff resources, by freeing staff to also work on other activities within their existing role.
Implementation Date
• Initial implementation went live on 27th Sept 2019 and worked fine initially then issues arose – had to be phased until finally resolved
• Final rollout was completed in mid November 2019.
Outputs and Outcomes
CHALLENGES, LOA, SKILLS & UTUAT
Issues and challenges
• Although the robot works well, when there are data issues the robot can fail and this requires the workers to trouble shoot the issue
Level of Automation
• Pre automation: Manager: 3; Worker1: 4; Worker2: 4
• Post automation: Manager1: 4; Worker1: 4; Worker2: 4
UTAUT Model Constructs and Questions
• Due to sample size, unable to determine the effectiveness of the model
• Some workers do not feel they are interacting with a robot therefore voluntariness exist
• New variables under facilitating conditions proposed
Impact
STRUCTURE OF WORK
(what it means for the worker and work undertaken)
Job Characteristics (Design, Role and Elements):
1) Job characteristics did not change. Workers had more time to focus on all their duties
2) Improve staff job satisfaction – some of the routine and repetitive activities now removed in turn allowing staff to focus on the more value added activities
3) The skills and qualifications required for the role remained unchanged
4) A key emerging element of the task that increased (more than envisaged) was the time being spent up front to get the data correct to ensure issues with the robot were minimised
5) New skills - there was still a need to deal with any issues reported by the robot – mainly data related
Skills Characteristics:
1) The robot has only automated a subset of the workers tasks – managers assumed it was a greater proportion of the workers time (twelve hours per week) than the worker have stated it is (up to four hours)
2) Given the specific task, no concerns raised about not being able to manually undertake the task at a future point
3) To build the robot, existing work instructions needed to provide more detailed steps on the keystrokes and the forms to be displayed. In addition, all exception scenarios had to be detailed and what should happen if each exception situation arose.
4) No change to workers, role; skills or knowledge have been realised
5) New skills gained to troubleshoot issues with the robot when it fails
6) Work still requires two workers to perform the task
Work Characteristics:
1) No impact on job security, wages, hours worked, training
2) Able to focus on the more value added activities
3) Up to 204 hours per annum being saved at present to process NAF for 6 organisations.
4) Work being undertaken by staff now is more value added than before, staff enjoying the role more

Case Study 4 - Roster:

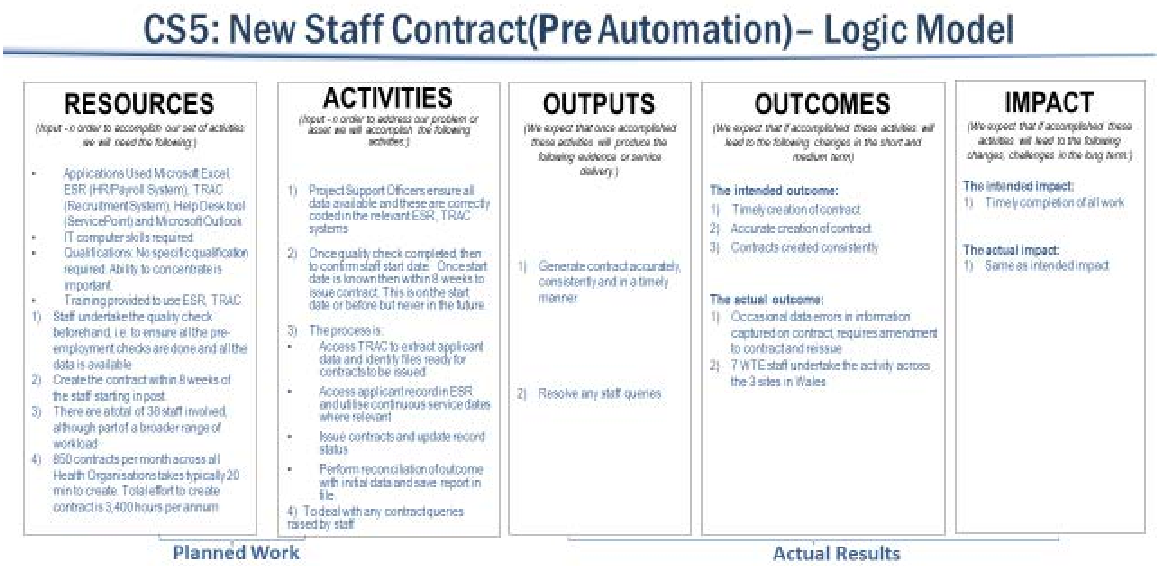





CS4: Shift Pattern Payment (Post Automation) – Logic Model
RESOURCES
(Input - in order to accomplish our set of activities we will need the following:)
• Applications Used Microsoft Excel, Oracle Finance system, Rostering System (RosterPro), Internet web sites to advertise shifts and Microsoft Outlook
• General IT computer skills and Microsoft Office skills required
• Qualifications: No specific qualification required
• Training in the specialist tools used, for instance Oracle Finance and RosterPro is provided
1) Work with Agencies, Wards/Departments, Shift Workers, Finance Dept, Accounts Payable Department.
2) Work activities all manual, involving 2 staff
3) Process about 1,800 new shift requests per week. About 140 shifts amended or cancelled. Time to complete information in both Rostering and Finance systems about 3 minutes (conservative estimate). Est. 4,700 hours per annum. Receipting shifts estimated at 1,600 hours per annum. Cancelling and amending orders about 300 hours per annum.
ACTIVITIES
(Input in order to address our problem or asset we will accomplish the following activities:)
1) Work with Wards and Departments to identify shifts
2) Publish available shifts on Web Portal and add shift onto RosterPro
3) Nurses contact TSD to confirm shifts to work and information updated on RosterPro
4) Need to ensure all shift rates, staff grades and shift details accurate captured in system. Also dates etc captured in a consistent format
5) Nurse works the shift, updates timesheet with details of shift worked, gets manager to counter sign and then sends the timesheet to Agency
6) Agency send in the invoice based on hours nurse works
7) The invoice is cross checked against timesheet to verify all the information is correct. Any issues are sent to the Ward/Dep to clarify
8) The invoice details then coded on RosterPro and Oracle Finance systems
9) If shifts confirmed then the user receipts the invoice on RosterPro and Oracle Finance
10) On occasion's the hours worked are different in which case the details are amended on the Rostering and Finance system
11) If the shift is not worked then the order is cancelled on RosterPro ~~and Finance system~~
Planned Work
OUTPUTS
(We expect that once accomplished these activities will produce the following evidence or service delivery:)
1) Ward/Department have agency cover when required
2) Agency gets paid promptly
3) Finance and Rostering systems are ~~sometimes~~ always up to date and reconcile between both systems
4) TSD update Rostering system and robot updates Finance system
5) Any issues with the file or data is referred back to the Ward/Department or Agency to correct/resolve
OUTCOMES
(We expect that if accomplished these activities will lead to the following changes in the short and medium term)
The intended outcome:
1) Timely update of all systems RosterPro and Oracle Finance, ~~less pressure on staff~~
2) Seamless reconciliation between timesheet, actual worked hours, RosterPro and Finance system
3) No disputes with timesheets and invoice payments and min. agency queries
4) Agency promptly paid, no invoices on hold
5) TSD having the capacity to handle increase shifts
The actual outcome:
1) As intended outcome
2) Has freed staff to focus on other value added activities
3) Less invoice disputes with agencies ,increased prompt payments, less errors entering overtime rates
4) All invoices now captured electronically
5) Able to work with an increased number of agencies
6) Invoices processed on time now 78% +
Actual Results
IMPACT
(We expect that if accomplished these activities will lead to the following changes, challenges in the long term.)
The intended impact:
1) Timely completion of all work activities
2) Ability to recover more credits from agencies
3) Coding more accurate
The actual impact:
1) As intended impact
2) Staff cannot live without the robot – concerned if it stopped working
~~3) Relationship with agencies sometimes difficult~~
~~4) Pressures on other departments such as Finance and Accounts Payable to help sort out mistakes~~
~~5) Credits notes due to the NHS not being recovered in every case due to backlog~~
~~6) All issues were sole destroying for staff~~
Level of automation delivered is level 3 and once the final agencies are live then we expect it to be a level 4
Legend
• "Red" = the previous manual activity now performed by the robot (either entirely or partially)
• "Green" = elements of the existing manual task that has changed to support the robot
• "strike-through" – steps of the process/activities that no longer takes place


CS4: Shift Pattern Payment (Key Themes / Findings) – Pre/Post Comparison
OVERVIEW
Quality of Work
• Quality of work for the workers have improved, less pressured
• Less human data coding errors being made
• Loading invoices used to take 7-8 min now takes less than a minute
Benefits
• Recovering overpayment credits back from agencies, previously did not have the time to do this
• Less pressure on staff, improved working environment
• Better relationship with agencies
• Can reduce headcount in TSD by one due to robot taking care of all Oracle Finance activities
Organisation
• Ability to better manage staff resources
• Ability to focus on other value added tasks,
• Able to ensure more time is given to data preparation
Implementation Date
• Initial pilot took place in July 2017 and then phased in
• Final rollout was completed in November 2018
Outputs and Outcomes
CHALLENGES, LOA, SKILLS & UTUAT
Issues and Challenges
• Suppliers - Will not move some suppliers (agencies) to be processed by the automated system unless TSD knew they would send data in the correct format and there were no issues with that supplier. At present TSD still do not have confidence in some suppliers to automate their paperwork.
• Data Preparation - Rebalance of work activities with more time spent up front to sort out that all data is correctly and accurately coded in the Rostering system. This ensure there issues with the robot
• Robot is only as good as the data held in the Rostering system
Level of Automation
• Pre automation: Manager1: 3 Worker1: 3
• Post automation: Manager1: 3 Worker1: 4
UTAUT Model Constructs and Questions
• Due to sample size, unable to determine the effectiveness of the model
• None of the workers deal with the robot. The robot deals with all the Oracle Finance activities removing the need for staff to now do any of this – therefore no need for staff to deal with the robot
Impact
STRUCTURE OF WORK
(what it means for the worker and work undertaken)
Job Characteristics (Design, Role and Elements)
1) Job characteristics did not change. The core elements of the role involving managing all aspects of the shift patterns, agencies and reconciliating all the data
2) Improve staff job satisfaction – some of the routine and repetitive activities now removed in turn allowing staff to focus on the more value added activities
3) 1 wte staff not required to manage volumes;
4) A key emerging element of the task that increased (more than envisaged) was the time being spent up front to ensure data in the Rostering system was always completed, accurate and correct – something staff should have been doing anyway!
5) Issues raised by the robot means task still need to be progressed by staff
6) There is still a need to deal with issues reported by the robot, for instance if it is unable to find the invoice or receipt an order. This could arise due to data issues or system issues, such as the network going down.
Skills Characteristics
1) The skills and qualifications required for the role remained unchanged
2) Given the specific task and that 10 suppliers are not being processed by the robot, we have no concerns about not being able to manually undertake the task
3) Concerns initially raised by staff as to what automation would mean for them but after the pilot these concerns disappeared
4) Need to prepare detailed work instructions to allow the development team to know how to build the robot and what the robot had to do if something went wrong. Was resource intensive
Work Characteristics
1) No impact on job security, wages, hours worked, training
2) Staff reported they would be mortified if robot wasn't there anymore
3) Able to focus on the more value added activities
4) Over 6,000 hours per annum being saved completing the Oracle Finance work, this is a huge saving.
5) Less issues reported by AP and Finance departments as part of completing the end to end process activities
6) Work being undertaken by staff is viewed as adding more value, with staff enjoying it more.

Case Study 5 - Contract:



CS5: New Staff Contract (Key Themes / Findings)– Logic Model

AUTOMATION IN ABEYANCE

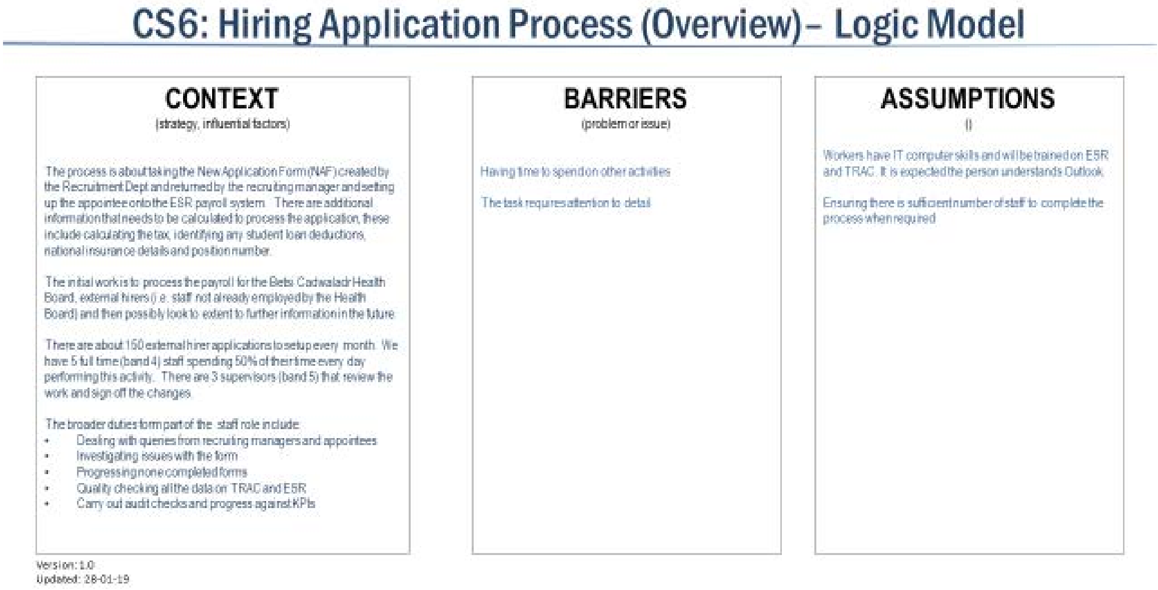
Reason for delay or cancellation

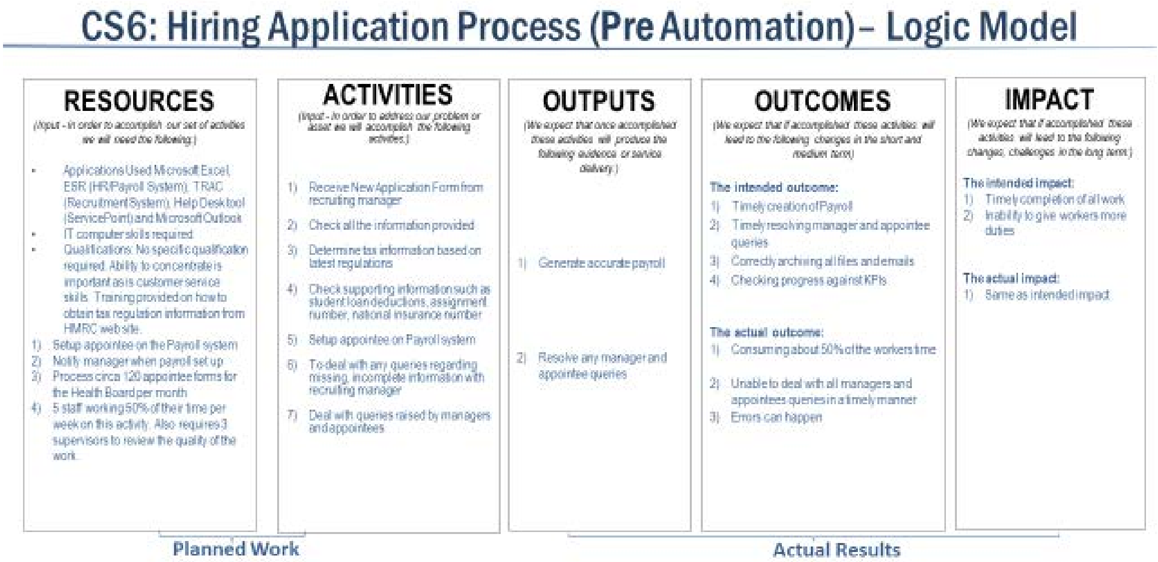
1) The automation of the task is delayed under further notice – no timescales provided
2) This followed a detailed review of the existing processes, updating all relevant work instructions, process maps and supporting information in readiness for automation
3) Managers felt it was necessary for more detailed consideration to be given on the understanding of which workers would have future process knowledge, skills to be able to support the robot if the robot failed or if the key applications used by the robot were updated that impacted on existing business processes
4) The managers felt risk was too great in not being able to issue contracts for new staff which is a legal requirement
5) The time spent updating the documentation has not been wasted, it has allowed for the managers to take a fresh look at their working practices and how they deliver their services
6) No decision has been taken on whether the automation of the process tasks will resume or whether this will be cancelled

Level of automation

Pre automation: Manager 1: 2; Manager 2: 2; Worker 1: 3; Worker 2: 3

Case Study 6 - Payroll:





CS6: Hiring Application Process (Key Themes / Findings)– Logic Model

AUTOMATION IN ABEYANCE

Reason for task delay or cancellation

1) Implementation of task automated was delayed under further notice – no timescales provided on whether the implementation would resume of if it would be cancelled
2) The department had spent a considerable amount of time reviewing and updating their work instructions and supporting process maps to support the planned automation. It was following this review the managers took a refresh look at how they delivered their services.
3) Managers felt more detailed consideration was required on the impact on which workers would have future process knowledge, skills to be able to support the robot if the robot failed or if the key applications used by the robot were updated that impacted on existing business processes
4) Department felt the present risk was too great in not being able to pay staff on time which is a legal requirement
5) The managers felt the time spent updating the documentation had not been wasted, it has allowed them to use the revised documentation to review their future working practices

Level of automation

Pre automation: Manager 1:3; Manager 2:3; Worker 1: 3

APPENDIX F – CASE STUDY STRUCTURE OF WORK COMPARISON SUMMARY

F1. Pre-Automation Summary Findings

Table 9 – Pre-Automation summary findings across the sites

Case Study Site	Summary of business process task and key features	Staff skills and qualifications	Constraints and challenges	Expectation from automation	Level of Automation (LoA) expected ** Key: See footnote*
Site 1: Statement	• Task involves reconciling supplier invoice statements against ordered recorded against the NHS Finance system • Task is routine, repetitive – performed every month • Task straightforward to perform • Task requires two workers and takes each worker 3 hours per day (40% of the workers time), or 1,320 hours per annum for two workers to perform – 0.73 FTE staff • Small team	• No specific qualifications or knowledge required • Workers on salary grade 2 (salary range £17k to £18k) and grade 3 (salary range £17k to £21k) • Workers typically educated to GCSE level • Training provided on systems used • Main skills necessary are telephone manners, use of spreadsheets and Finance system	• Tasks is reactive – performed when supplier queries payments • Task is resource intensive • There is a backlog of work • Workers not able to complete all aspects of their role • Workers had to prioritise what was important • Missed opportunities to recover overpayments and missed opportunities to make savings.	• Reduce time spent on mundane and repetitive tasks • More time liaising with customers • Streamlined process, less pressure on staff • Improvement on present process • Not about reducing staff numbers	Manager1 - 3 Manager2 - 3 Worker1 - 3 Worker2 - 3
Site 2: Catalogue	• The task is to ensure the supplier catalogue entries on the IT systems are up to date • Task is routine and repetitive – has to be completed by a set due date every month • Task straightforward to perform • Each task takes 0.2 minutes per catalogue lines. The number of	• No specific qualifications or knowledge needed • Workers on salary grade 2 (salary range £17k to £18k) and grade 3 (salary range £17k to £21k) • Workers typically educated to GCSE level	• Mistakes happening, data entry accuracy was important • Activities are manual and resource intensive. • Workers not able to allocate sufficient time to complete all aspects of their role	• Less mistakes, greater data accuracy and consistency • Better use of workers time • Improvement on present process, with managers	Manager1 - 4 Manager2 - 4 Worker1 - 4 Worker2 - 4 Worker3 - 3

	lines can vary per health organisation and the number of suppliers – can be hundreds or thousands each day. Based on an average of 5,200 tasks per annum, this takes about 1,040 hours to perform, equating to 0.58 FTE staff • Small team	• Training provided on systems used, skills required in using spreadsheets and Procurement system, computer skills expected		expecting the robot to do most of the task • Not about reducing staff numbers	
Site 3: Appointment	• Task relates to processing the new appointment form for a person that has been appointed into a position within the NHS • Task is straightforward for internal applicants only and these are the ones under consideration for automation • Task is very routine and repetitive • 240 tasks per annum is consuming about 960 hours (for five NHS Organisations) – about 0.53 FTE staff • Small team	• No specific qualifications or knowledge needed Workers on salary grade 3 (salary range £17k to 21k) and salary grade 6 (salary range £28k to £35k) • Workers typically educated to A level • Training provided in systems used, skills required in customer service • Skills required in payroll and recruitment systems, attention to detail was important,	• Mistakes happening, data entry accuracy and attention to detail is important • Workers not able to complete all aspects of their role • Workers had to prioritise what was important • Activities manual and resource intensive	• Improvement on activities • Help meet performance targets • Prevent need to appoint more workers • Manage greater volume of work • Not about reducing staff numbers	Manager1 - 3 Worker1 - 4 Worker2 - 4

Site 4: Roster	• Task is to ensure orders are placed with agencies for shift workers and ensuring prompt payment of invoices • Task is routine and repetitive • Orders need to be promptly raised and invoices promptly paid • Managing the data entry for 3,480 tasks in the rostering and Finance systems was estimated to be taking 126 hours per week (6,500 hours per annum) equivalent to 3.6 FTE staff • Small team	• No specific qualifications or knowledge needed Workers on salary grade of 2 (salary range £17k to £18k) and grade 4 (salary range £20k to £23k) • Workers typically educated to GCSE level • Training provided in systems used • Staff expected to have skills in Excel and Outlook email system, • Data entry accuracy and have attention to detail is essential	• Task straightforward, task had to be completed by a set date every month • Not all tasks completed in a timely manner, backlog of work • Missed opportunities to make savings • Activities manual and resource intensive.	• Improvement on activities • Reduce pressure on staff • Free workers time to focus on data quality • Reduce reliance on agency workers during peak demands	Manager1 - 3 Worker1 - 3
Site 5: Contract	• Task is to ensure new employments contracts are prepared for staff joining a health organisation or moving into a new position in a health organisation • Task is routine and repetitive – has to be completed within 8 weeks of the request being received • Task straightforward to perform • One worker processed between 30 and 40 contracts per 7.5 hour day – about 1.89 FTE staff • Team size is 39 staff	• No specific qualifications or knowledge needed Workers on salary grade 2 (salary range £17k to £18k) and grade 3 (salary range £17k to £21k) • • Workers are typically educated to GCSE level • Training provided on systems used, skills required in customer service, skills required in the payroll system and recruitment system, aptitude required	• Mistakes happening • Data entry accuracy and attention to detail was important • Activities manual and resource intensive.	• Less mistakes, greater data accuracy and consistency • Reduced number of workers • Not expecting robot to deal with all transactions • Not about reducing staff numbers	Manager1 - 2 Manager2 - 2 Worker1 - 3 Worker2 - 3
Site 6: Payroll	• The task is about ensuring new appointees are correctly setup on the payroll system to receive a salary, expenses and any other	• No specific qualifications or knowledge needed • Workers on salary grade 4 (salary range £20k to £23k)	• Task had to be completed by a set date every month	• Improvement on activities	Manager1 - 3 Manager2 - 3 Worker1 - 3

	remunerations based on the terms of their employment • Task is very routine and repetitive • Task is time consuming – takes five workers spending 50% of their time (3.75 hours per day per worker) to process 120 appointee forms per month - about 2.3 FTE staff • Team size 8 staff	and grade 5 (salary range £23k to £29k) • Workers typically educated to GCSE level or A level • Training provided in systems used, skills required in and recruitment system, staff expected to have skills in Excel and Outlook • data entry accuracy and attention to detail is important	• Not all tasks completed in a timely manner • Missed opportunities to recover overpayments • Activities manual and resource intensive.	• Free workers time to focus on data quality • Reduce reliance on agency workers during peak demands	

* Note:

- *LoA:2 – Partial automation (up to 50% performed by automation); LoA:3 - Conditional Automation (up to 75% performed by automation)*
- *LoA:4 - High automation (up to 99.9% performed by automation, the rest by Human activity)*

F2. Post-Automation Summary Findings

Table 10 – Post-Automation summary findings across the sites

Case Study Sites	Summary of additional findings		
	Automation build considerations	**Savings Opportunity (expected)**	**Level of Automation (LoA) delivered** ***Key:*** *See footnote*
Site 1: Statement	• More detailed work instructions required • Considerable effort to prepare process maps • Time required to address data quality issues	• Workers' estimated time saved 770 hours per annum – 0.42 FTE staff savings. • The workers effort estimated to reduce from 1,320 to 550 hours per annum – 42% activity saving	Manager1 - 3 Manager2 - 3 Worker1 - 2 Worker2 - 2
Site 2: Catalogue	• More detailed work instructions required • Considerable effort to prepare process maps • Time required to address data quality issues	• Workers estimated time saved 1,040 hours per annum - 0.58 FTE staff saved. • The workers effort estimated to reduce from 1,040 to 0 hours per annum to perform this specific task – 100% activity saving	Manager1 - 2 Manager2 - 2 Worker1 - 3 Worker2 - 3 Worker3 - 1
Site 3: Appointment	• More detailed work instructions required • Considerable effort to prepare process maps • Time required to address data quality issues	• Workers estimated time saved 204 hours per annum for the five organisations – 0.11 FTE staff savings. • The workers effort estimated to reduce from 960 hours to complete the task to 756 hours – 21% activity saving. Work still requires two workers to perform some aspects of the task • Number of tasks: 240	Manager1 - 4 Worker1 - 4 Worker2 - 4
Site 4: Rostering	• More detailed work instructions required • Considerable effort to prepare process maps • Time required to address data quality issues	• Workers estimated time saved 4576 hours per annum – about 2.5 FTE staff saving • The workers effort estimated to reduce from 6,573 to 1997 hours per annum – activity 69% saving	Manager1 -3 Worker1 - 4

		• Agency worker no longer required – job loss. • Team now processing 76% of invoices on time (up from 27%)	
Site 5: Contract	• More detailed work instructions required • Considerable effort to prepare process maps	Information not available - frequency of application changes made it too risk to replace worker with automation	Not available - project moved into abeyance
Site 6: Payroll	• More detailed work instructions required • Considerable effort to prepare process maps	Information not available - risk to existing processes too great	Not available - project moved into abeyance

* Note:

- *LoA:1 - Human Assistance (up to 25% performed by automation, the rest by human activity)*
- *LoA:2 - Partial automation (up to 50% performed by automation, the rest by human activity)*
- *LoA:3 - Conditional Automation (up to 75% performed by automation, the rest by human activity)*
- *LoA:4 - High automation (up to 99% performed by automation, the rest by human activity)*

APPENDIX G – CASE STUDY UTAUT FINDINGS COMPARISON

Table 11 – UTAUT summary findings across the sites

UTAUT Construct Questions		Statement.Manager1		Statement.Worker1		Statement.Worker2	
Question # **	Questionnaire Statement	Response (1 to 5)*	Reason for your response	Response (1 to 5)*	Reason for your response	Response (1 to 5)*	Reason for your response
1	The automation is useful in my job	n/a	n/a	4	Robot reduces time taken to complete repetitive task, allowing time to be allocated to other duties	5	Reconciles statements much quicker than manually reconciling
2	The automation allows me to do my job more quickly than before	n/a	n/a	4	Reduces time taken to complete task by approximately two thirds	4	Reconciles statements quicker than manually reconciling but Qlikview process which has been introduced for non-Top 100 suppliers is almost as quick
3	The automation has helped to do my job more accurately than before	n/a	n/a	3	Robot is less accurate than completing task manually put can output additional information	2	Can at times be unreliable with statements timing out, finding invoices for incorrect suppliers or failing to find invoices on the system – although it's a slow process, manually reconciling a statement is more accurate
4	The automation has allowed me to save time to focus on other duties	n/a	n/a	4	Robot reduces time taken to complete task two thirds, allowing time to be allocated to other duties	4	Able to focus more on payment runs, answering phones and dealing with emails than previously
5	The automation provides me with accurate and consistent information every time	n/a	n/a	4	Approximately 1 in 20 output files contain errors due to server response times	1	Have had issues with statements timing out, finding invoices for incorrect suppliers or failing to find invoices on the system – although it's a slow process, manually reconciling a statement is more accurate

6	The automation has allowed me to make better use of my skills	n/a	n/a	4	Using the robot involves less repetition than completing the task previous and more problem solving skills in managing the robot	4	Excel, time-management and problem-solving skills have been put to use through using the robot
7	I am comfortable working with the automation	n/a	n/a	5	The process is fully documented and I understand how to troubleshoot and resolve common issues.	5	Have experience using the robot for 9 months so am comfortable using it
8	I have to always use the automation to undertake the process/task	n/a	n/a	3	The robot is only used for specific suppliers, where a fast resolution is required the manual process is still used as robot is run overnight.	3	The robot is used for a specific set of suppliers
9	I can look for new opportunities in the organisation because the process/task is now performed by the automation	n/a	n/a	3	The robot hasn't had a significant enough impact on my current role to make additional opportunities in the organisation available to me	3	I haven't seen a chance for new opportunities from the robot, however it has meant we are able to reconcile statements for more suppliers now we have increased the number of dedicated suppliers used by the robot from 50 to 100
10	Learning what I could do with the automation was easy for me	n/a	n/a	5	The process is fully documented and I already had a good understanding of the manual process	3	Has been a process to learn how to use the robot as we have come across issues which we have had to firefight as we go along
11	Interacting with the automation is easy	n/a	n/a	4	Performing the task the robot is set up for is straightforward, but making amendments not relating to functionality requires going through the robotics team	3	Can sometimes be difficult to interpret why the robot may have failed to reconcile a statement

12	Setting up the automation to correctly undertake the process/task was easy	n/a	n/a	N/A	Was not involved with initial set up of robot	2	Have been met with multiple issues when undertaking the process and producing correct statements from the robot with issues concerning statements timing out, finding invoices for incorrect suppliers or failing to find invoices on the system – although it's a slow process, manually reconciling a statement is more accurate
13	Using the automation takes too much time and effort away from performing my normal duties	n/a	n/a	2	Overall the robot saves time	2	The process is quicker than those that were previously in place
14	I trust the automation to complete its activities correctly every time	3	So far we have been impressed with the robot but it is too early to say. We have more suppliers we wish to push through the robot and wish to enhance the robot to deal with more data issues. Once we can address this then I think we will start to have more confidence	4	The output from the robot still needs to be spot checked as errors occur on occasion	2	Don't necessarily trust the robot to produce an accurate statement and feel the need to check the end statement each time to make sure it hasn't failed (see issues mention in question c)
15	I trust the automation to tell me when it is having issues in completing the process / task	4	We can see from the report what the robot has processed and any issues it has	3	The robot identifies and highlights approximately half instances where input will result in incorrect output	3	The robot doesn't always inform us when a statement has failed – it may if it has been rejected but if the statement has timed out, picked up incorrect invoices or failed to find

			reported. At the moment we still do the occasion spot checks				invoices we have to check the statement and figure this out ourselves
16	I have the necessary resources (training, procedure, guidance) to enable me to understand and work with the automation	n/a	n/a	5	The process is fully documented and I take an active role in its development and improvement	5	I have been provided with extensive training on how to use the robot and understand how it works
17	A specific person is available to provide me with assistance when there are difficulties with the automation	n/a	n/a	5	We have a dedicated robotics team email address and designated contact	5	There is a dedicated team we could contact should we encounter any issues
18	I know who to contact if the automation stopped working or if I noticed an issue	5	We have the RPA Team contact details	5	We have a dedicated robotics team email address and designated contact	5	I know who to contact if there has been an issue with the robot or a statement
19	I am confident someone in my department will know if the automation is not completing its tasks correctly	4	As per my previous comment, we can see the reports that are produced from the robot to know if there have been any issues	5	The outputs from the robot are routinely checked for accuracy and issues reported to robotics team	4	I feel fairly confident in myself and Richard's ability to identify issues with the robot and statements
20	If the automation stopped working and could not continue then we still have the resources in the team to perform the process/task manually	3	This is a difficult one because we want the staff to do other duties. If the robot stopped then we will need to decide whether we could wait but it depends on	4	The team have the relevant skills to perform the task without the robot although at a reduced volume without reallocating time from other task	3	The team would be able to continue reconciling statements via the Qlikview process which is accurate but more time-consuming and so other tasks would take a hit

			whether the supplier then phones us for an update, especially if they are used to receiving reports from the robot every month				
21	If the automation stopped working and could not continue then we still have the knowledge and skills to perform the process/task manually	3	The task wasn't difficult but I am sure we would be able to pick it up again if we had to. Ideally, we don't want to be in this position.	5	We are continuing to develop the manual process that the robot replicates	5	We have two other processes that the team would be able to use to reconcile statements either manually or via Qlikview
22	My job role has changed because of the tasks now performed by the automation	n/a	n/a	4	As the robot reduces the time originally taken to complete repetitive task, this allows time to be allocated to other duties such as training of other team members	4	Other tasks can be assigned to me as the robot lowers the amount of time dedicated to reconciling statements
23	My skills have changed because of the tasks now performed by the automation	n/a	n/a	4	Using the robot has improve my skill in troubleshooting issues	4	Troubleshooting and problem-solving skills have definitely improved

UTAUT Construct Questions		Catalogue.Manager1		Catalogue.Worker1		Catalogue.Worker2		Catalogue.Worker3	
Question # **	**Questionnaire Statement**	**Response** (1 to 5) *	**Reason for your response**	**Response** (1 to 5) *	**Reason for your response**	**Response** (1 to 5) *	**Reason for your response**	**Response** (1 to 5) *	**Reason for your response**
1	The automation is useful in my job	N/A	More of a question relating to the workers	4	Taken over the more mundane tasks	5	We can do other tasks such as catalogue cleansing	5	It allows more time to do other tasks, such as cleansing, room booking etc
2	The automation allows me to do my job more quickly than before	N/A	Ditto	3	Frees up time for staff to do other things	3	It has taken the whole extending task from us so I don't update catalogues anymore, and when it has had problems we have done the whole process so it hasn't helped me do it quicker	3	Extending the Agreements is only part of our job, but it hasn't made other tasks quicker
3	The automation has helped to do my job more accurately than before	N/A	Ditto	3	It's only as accurate as the information given- and checked before the process.	2	It has at times failed to perform	2	No, in that if I don't do the task, then I am unable to do the task more accurately.
4	The automation has allowed me to save time to focus on other duties	N/A	Ditto	4	Can do additional work or cleansing	2	Extend agreements by missing lines to extend	5	Yes
5	The automation provides me with	N/A	Ditto	4		5	We can do jobs such as	3	Don't know

	accurate and consistent information every time						catalogue cleansing		
6	The automation has allowed me to make better use of my skills	N/A	Ditto	3		3	Don’t know	3	Don’t know
7	I am comfortable working with the automation	N/A	Ditto	4		3	Don’t know	3	Not in my role to work with the Robot
8	I have to always use the automation to undertake the process/task	N/A	N/A	N/A		5	Mark assists when there is difficulties	3	Not applicable
9	I can look for new opportunities in the organisation because the process/task is now performed by the automation	1	This task is only a very subset of the job role and those that I am responsible for managing	2				3	Not applicable
10	Learning what I could do with the automation was easy for me	N/A	Ditto	N/A		3	I haven’t worked with the Robot	3	Not in my role to work with the Robot
11	Interacting with the automation is easy	N/A	Ditto	N/A		3	I haven’t worked with the Robot	3	Not in my role to work with the Robot
12	Setting up the automation to correctly undertake the process/task was easy	2	It was fine until we had issues back in March. When it failed we struggled to understand the issues and this has taken some time to understand and fix in the robot	N/A		3	I haven’t worked with the Robot	3	Not in my role to work with the Robot

13	Using the automation takes too much time and effort away from performing my normal duties	3	It has in recent months but only because of the issues we have had. We have been reassured these issues have been fixed.	2	More time has to be spent checking that the data is correct to send to the robot.	1	I don't know	3	Not applicable
14	I trust the automation to complete its activities correctly every time	3	It was fine during the initial 2 months then we had an over 50% failure rate from the robot and this has taken time to fix. So at present it is too early to say	4	It's an automated function	3	I haven't worked with the Robot	3	Not in my role to work with the Robot
15	I trust the automation to tell me when it is having issues in completing the process / task	3	For the same reason as previous answer. We have had to do validation checks at the end to double check it is working rather than necessarily relying on the robot to tell us.	4	It provides us with a report of what has been completed	3	I haven't worked with the Robot	3	Not in my role to work with the Robot
16	I have the necessary resources (training, procedure, guidance) to enable me to understand and work with the automation	3	This is only the case when it works. When it doesn't work then sometimes we are scratching our heads to understand why it has failed.	N/A		3	I don't use the robot	3	Not applicable

17	A specific person is available to provide me with assistance when there are difficulties with the automation	4	We contact the RPA Development Team	N/A		3	I don't use the robot	5	Mark McBean assists when there is a problem with the robot
18	I know who to contact if the automation stopped working or if I noticed an issue	5	We contact the RPA Development Team	4	The task could be given back to the team to do.	3	I haven't worked with the Robot	3	Don't Know
19	I am confident someone in my department will know if the automation is not completing its tasks correctly	4	As per my previous comment, we carry out end of process validation checks	5	As above	5	Mark assists when there is difficulties	3	Don't' Know
20	If the automation stopped working and could not continue then we still have the resources in the team to perform the process/task manually	3	This would not be the ideal situation as one of the reasons for the robot was to take away the high labour intensive, routine work	5	As above	3	I don't use the robot	5	Yes, the task would be given back to us and we would be able to extend Agreements.
21	If the automation stopped working and could not continue then we still have the knowledge and skills to perform the process/task manually	4	This particular task is very simple and doesn't require any detailed understanding	5	As above	3	I Don't know	5	Yes, the task could still be done as previously.
22	My job role has changed because of the tasks now performed by the automation	1	This task is only a very subset of the job role and those that I am responsible for managing	2	My job role hasn't changed	3	I don't use the robot	3	My job role has not changed

23	My skills have changed because of the tasks now performed by the automation	1	This task is only a very subset of the job role and those that I am responsible for managing	2	My skills haven't changed	3	The only change is rather than extending catalogues I can now cleanse more catalogues	3	My skills have not changed

UTAUT Construct Questions

Question # **	Questionnaire Statement	Appointment.Worker1 Response (1 to 5) *	Appointment.Worker1 Reason for your response	Roster.Manager1 Response (1 to 5) *	Roster.Manager1 Reason for your response	Roster.Worker1 Response (1 to 5) *	Roster.Worker1 Reason for your response
1	The automation is useful in my job	3	Spend many hours resolving issues or checking the robots daily weekly reports to ensure its completed tasks correctly	5	It deals with all the Oracle Finance elements. It means less pressure on my team	3	I don't deal with the robot, I just key data onto the Rostering system and that is it.
2	The automation allows me to do my job more quickly than before	3	As above	5	Allows me to reassign staff resources to additional tasks	3	As above
3	The automation has helped to do my job more accurately than before	2	On times accuracy due to issues has caused issues that will not arise if it was manual	5	As above	3	As above
4	The automation has allowed me to save time to focus on other duties	2	Spend many hours resolving issues or checking the robots daily weekly reports to ensure its completed tasks correctly. Time saved in one hand and taken in another	5	As above. I need to spend less time also performing the tasks when demand is high	3	As above
5	The automation provides me with accurate and consistent information every time	4	Only supplies information if it has ran correctly.	5	Works well	3	As above

6	The automation has allowed me to make better use of my skills	2	Not been able to develop any skills apart from understanding the robots process	5	Less firefighting and more time doing what I am meant to do	4	I no longer need to worry about updating the finance system, that has helped a lot
7	I am comfortable working with the automation	4	I'm comfortable working with the developer	5	We don't work with the report. We get reports on what the robot has processed and this tells us whether we had any issues	3	I don't work with the robot, I just focus my time updating the rostering system, determining what shifts need to be managed and dealing with specific queries raised by agencies
8	I have to always use the automation to undertake the process/task	3		1	We could not do without the robot	3	As above
9	I can look for new opportunities in the organisation because the process/task is now performed by the automation	3	This cannot be achieved at the moment due to other responsibilities	1	As above	3	The robot has helped one strand of the overall work I used to do
10	Learning what I could do with the automation was easy for me	4	Have built knowledge but allot is still unknown on the robots full potential	5	As above	3	As above
11	Interacting with the automation is easy	4	Interacting with the developer or RPA team is easy	3	We don't work with the robot at all	3	As above
12	Setting up the automation to correctly undertake the process/task was easy	2	Lots of issues with website built for chrome	3	As above	3	As above
13	Using the automation takes too much time and effort away from performing my normal duties	3	Adds additional duties	1	Definitely not, we could not do without the robot	3	As above

14	I trust the automation to complete its activities correctly every time	3	Each day is an expectation of has it ran correctly	5	As above	3	As above
15	I trust the automation to tell me when it is having issues in completing the process / task	5	The developer is always a step ahead	3	As above	3	As above
16	I have the necessary resources (training, procedure, guidance) to enable me to understand and work with the automation	4	I consult the developer	5	We don't work with the robot	3	As above
17	A specific person is available to provide me with assistance when there are difficulties with the automation	5	The developer and manager	1	Yes, we contact Central Team eBusiness Services	3	As above
18	I know who to contact if the automation stopped working or if I noticed an issue	5	The team are on speed dial I'd like to say	5	Yes	3	As above
19	I am confident someone in my department will know if the automation is not completing its tasks correctly	4	Niall and Donna can be notified in my absence	5	We are notified from the reports produced by the robot what the issues have been and we then look to fix the issues	3	As above
20	If the automation stopped working and could not continue then we still have the resources in the team to perform the process/task manually	4		1	We are totally reliant on the robot. We are not sure what we would do anymore without the robot	3	As above

21	If the automation stopped working and could not continue then we still have the knowledge and skills to perform the process/task manually	4	The team will have to refer to the recent guidance created to update them on the changes in the process	5	This is worse case scenario for us	3	As above
22	My job role has changed because of the tasks now performed by the automation	2	No change apart from not doing the NAF process manually.	1	Job role remains unchanged, still same duties. Just means less pressure, less mistakes being made. We can do more with the limited resources we have and provide a better service	3	It has freed up my time to focus on the work I need to be doing which is manage what resources are needed on the wards. The role and duties needed to perform the role have not changed. It has taken some pressure off me and allowed me to focus my time where it is needed
23	My skills have changed because of the tasks now performed by the automation	4	More knowledge on robot process	1	As above	3	The skills needed remain the same, although I don't need to enter data in the finance system I still need to enter data in the Rostering system

Note: * **5 Point Likert Scale:** ***1*** *= Strongly Disagree;* ***2*** *= Disagree;* ***3*** *= neither Agree nor Disagree;* ***4*** *= Agree****;*** ***5*** *= Strongly Agree*
**** Questions:** 1 to 9 = performance expectancy; 10 to 13 = effort expectancy; 14 to 17 = social influence; 18 to 23 = facilitating condition