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Opening the Black Box: Exploring the Socio-technical Dynamics and Key Principles of RPA Implementation Projects

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Full research paper

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Abstract

Robotic process automation (RPA) is gaining in popularity as organisations in various industries jump on the RPA bandwagon. However, organisations often face a range of challenges during implementation and may struggle to achieve the expected benefits from their investment in RPA. Systematic frameworks that address these challenges and can guide organisations in their RPA implementation endeavours are needed. Building on process and socio-technical theory, we addressed this gap by conducting a qualitative case study of an RPA implementation in an Australasian university. We interviewed 13 employees from the university and the RPA vendor. Our findings show how the RPA project unfolded and the intertwining effects on the different components of the socio-technical system at project, work system and organisational levels. Further, we propose eight socio-technical design principles that can guide organisations during their RPA implementations and may lead to higher success rates.

Keywords case study, hybrid processing, robotic process automation, socio-technical design principles, socio-technical theory

1 Introduction

Robotic Process Automation (RPA) has been adopted across many industry sectors that include routine administrative and support processes in their service delivery (Hofmann et al. 2020; Syed et al. 2020). RPA automates repetitive and monotonous tasks by configuring software robots or 'bots' to mimic the actions of a human employee (Syed et al. 2020; Wellmann et al. 2020). The RPA market sees a growing demand every year and is expected to reach a market value of $2.9 billion in 2021 as opposed to $250 million in 2016. It has also been predicted that over 4 million robots will be working on administrative, sales and related support tasks by 2021 (Santos et al. 2019). We adopt the definition of RPA provided by IEEE (2017, p. 11) as: "a preconfigured software instance that uses business rules and predefined activity choreography to complete the autonomous execution of a combination of processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management."

Organisations implement RPA to a) implement an automation technology with a quick project timeline that requires no or little change to underlying systems (Hofmann et al. 2020; Syed et al. 2020); b) increase productivity using bots and enabling employees to focus on more complex tasks that add more value to the organisation (Santos et al. 2019); c) reduce operating and transaction process costs (Syed et al. 2020); and d) increase compliance and reduce error rates (Moffitt et al. 2018). While the potential benefits have led to increasing uptake of RPA (Syed et al. 2020), organisations must learn how to manage RPA adoption and integration in their organisational context to realise these expectations (Lacity and Willcocks 2016). A range of issues confront organisations during RPA implementation, threatening the success of RPA projects and value maximisation from the organisation's investment in RPA (EY 2016; Lacity and Willcocks 2021).These include resistance to change, integration and maintenance issues, and process selection (Santos et al. 2019; Syed et al. 2020).

While general guidelines for implementing RPA are available, there is a need for systematic frameworks that explore critical success factors and their implications across the different phases of RPA implementation (Syed et al. 2020). In this study, we aim to open the black box of RPA implementation to better understand how issues that might occur affect both social and technical aspects of RPA implementation, including the different actors, structures and technologies involved. Further, we want to explore how those issues can be mitigated in order to achieve RPA implementation success and allow organisations to realise the benefits of RPA. Taking a process perspective (Van de Ven and Poole 2005) and building on socio-technical theory (Leavitt 1964; Lyytinen and Newman 2008), we pose the following research questions: *"How can RPA implementation be understood as socio-technical systems change"* and *"What principles can be applied to increase the likelihood of RPA implementation success?"* To answer our research questions, we conducted a qualitative case study (Tetnowski 2015) to understand how RPA adoption, implementation and use unfolded in the student administration division of an Australasian university. We contribute to the RPA literature by showing: a) how the different issues and events that occur in an RPA implementation project affect various socio-technical components on different system levels; and b) the strategies that were applied to address those issues and events and their associated outcomes. Further, we present a framework that proposes eight socio-technical design principles to help organisations to be successful in their RPA implementation projects.

2 Theoretical Background

2.1 Robotic Process Automation

The most common form of software robots are rule-based bots, which carry out tasks that are structured with predefined rules, repetitive and of high volume (Aguirre and Rodriguez 2017; Hofmann et al. 2020; Moffitt et al. 2018). Attended bots require human intervention to trigger the bot to complete various tasks. In contrast, unattended bots work autonomously and continuously, usually on entire simpler processes (Syed et al. 2020). The software robot that is implemented in our case study can be classified as a rule-based, unattended bot.

Organisations implement RPA to realise technical, social and organisational benefits. One of the biggest technical advantages is that RPA usually requires little or no change in the underlying IT infrastructure (Aguirre and Rodriguez 2017). Further, in comparison to other automation technologies, RPA has a relatively short project timeline from initiation to production that would typically only take 4-6 weeks (Hofmann et al. 2020). From a social perspective, employees tend to experience increased job satisfaction after RPA has been implemented. They have more time to work on cognitively stimulating activities that require decision-making and problem-solving skills rather than completing mundane and repetitive tasks and processes (Lacity and Willcocks 2016; Santos et al. 2019). Organisations benefit in terms of operational efficiency, increasing their productivity as bots can work 24/7 (Moffitt et al. 2018). They can also reduce their operating costs as the bots may decrease the FTE count and lower transaction processing costs, often by 30-60% (Syed et al. 2020). Additional benefits include faster response times, an increase in compliance and reduced error rates, which in turn may lead to increased customer satisfaction (Lacity and Willcocks 2016; Moffitt et al. 2018; Willcocks et al. 2015).

However, RPA implementation projects face various challenges that potentially threaten the ability of organisations to leverage the benefits of their investment in RPA. RPA relies on the collaboration between bots and humans to work most effectively. Prior to RPA implementation some employees may become anxious when their typical work practices change, viewing bots as a threat to their job security (Santos et al. 2019; Syed et al. 2020). This fear is not unfounded as RPA implementation often leads to job redesign, relocating employees to other positions within the organisation, or job loss (Santos et al. 2019). This creates tension in the workplace as employees resist the change associated with RPA implementation. Resistance to change can significantly impact the success of the project if the employees boycott implementation activities or provide misleading information. Technical challenges in RPA include slow performance, integration problems between RPA and the application it will interface with, and regular reconfigurations of the bot due to updates to the underlying system, which can be time-consuming, complex, and expensive (Santos et al. 2019). Further, the change in access control from human to bot can create organisational security and compliance threats (Syed et al. 2020; Willcocks et al. 2015). Bots must be programmed with safeguards that adhere to organisational security standards. Another challenge is the selection of appropriate business processes or process activities for automation and their quality. RPA works best on processes that involve structured service activities previously performed by humans. Ideal candidate processes for automation are high-volume, repetitive, well-specified processes with relatively low process variations and exceptions. Without process redesign, any inefficiencies or errors in the existing processes are reproduced by the bot (Wellmann et al. 2020).

For organisations to realise the benefits they need to overcome the challenges of RPA implementation. However, there is a dearth of research that provides clear strategies on how to implement RPA successfully. There is a need for an empirically derived and theory-informed framework (Syed et al. 2020) that can guide organisations to circumvent the challenges that occur and help them to navigate the complexities of RPA implementation and its effects on the organisation. In order to develop such a framework, we take a process perspective informed by socio-technical systems theory to examine: a) the complexities and interdependencies of various socio-technical components across multiple levels; b) how the challenges encountered during RPA projects affect the existing socio-technical system; and c) what principles might help organisations to achieve RPA implementation success.

2.2 RPA Implementation as Socio-Technical Change

We adopt a process perspective (Van de Ven and Poole 2005) to examine the phenomenon of RPA implementation as a complex, non-linear and multi-dimensional process, the outcome of which is non-deterministic and emerges over time. Outcomes are analysed as the result of a sequence of events and actions in order to open up the 'black box' of the process by which change occurs. We view RPA implementation as socio-technical change (Lyttinen and Newman 2008; McLeod and Doolin 2012). That is, neither considering it primarily as a technical process to be engineered nor a social process dominated by the interests of human actors, but simultaneously addressing both aspects and the reciprocal relationship between them. The implementation of RPA in an organisation is a function of dynamic interactions between the RPA technology itself, the human actors who appropriate it for particular purposes, and the institutional context in which it is deployed (Orlikowski 1992).

To inform our analysis, we draw upon Leavitt's (1964) model of a socio-technical system as four interacting components: people (actors), task, structure and technology. The mutual interdependencies between these four components ensure that a system tends towards a stable state. However, system change can occur when a change in one component causes an effect on one or more other components. Lyttinen and Newman (2008) explain this as a gap or misalignment between two or components that, if left unattended, threatens the stability of the system. They suggest that critical incidents or events generate such contingencies, and that interventions within the system are required to mitigate or remove gaps and to re-align the system components. Of course, interventions are not always successful. Some may fail, whether because of randomness, the complex interdependencies between components or an actor's inadequate performance. In addition, particular interventions can create unintended effects that further impact the system (Lyttinen and Newman 2008). This focus on critical events and path-dependent outcomes makes the socio-technical system model a useful tool for process analysis.

Although relatively simple, the socio-technical system model can be applied to IS related development and change (Lyttinen et al. 1996, 1998; Lyttinen and Newman 2008). It provides a framework with which to analyse both actor-oriented and structure-oriented aspects of information technology use in organisations (Sawyer et al. 2003), as well as material aspects of the technological artefact (Orlikowski and Iacono 2001). We follow Lyttinen and Newman (2008) in approaching IS related change as multi-level. The implementation of RPA is planned and deliberate and involves activities within a 'build system' or *project* level. The introduction of RPA reconfigures a particular *work system* that precedes, but interrelates with, the project. Finally, the project and work system are embedded in an *organisational* context which shapes (and is shaped by) the actions and effects at the other two levels.

The four socio-technical components can be applied at all three levels. For example, in analysing RPA development as a socio-technical system at the project level, *actors* are the project participants and stakeholders who influence the development (e.g. vendors, developers, users, managers) and their characteristics, expectations and interests. *Task* refers to project scope, goals and deliverables, as well as how development is accomplished. *Technology* includes the RPA platform, development tools and relevant elements of the organisation's technological infrastructure. *Structure* represents the institutionalised rules and arrangements that shape actors' choices and behaviour, including for example the formal project organisation and decision-making structure (Lyttinen et al. 1998; Lyttinen and Newman 2008; McLeod and Doolin 2012). Analogously, activities at the work system and organisational levels can also be analysed using the four socio-technical components (see Lyttinen and Newman 2008, for further examples). Analysing RPA implementation as socio-technical change enables us to shed light on the process of RPA implementation and explore the contextual dynamics between the different socio-technical components and across multiple levels.

3 Research Design

To answer our research questions, we conducted a qualitative case study based on an interpretative research approach (Myers and Walsham 1998). The case study method was appropriate as it provides an exploratory analysis to evaluate a phenomenon, in our case, RPA implementation projects, within a specific real-life environment; here, an Australasian university (Tetnowski 2015). Like many others, our case university is experiencing pressure to keep costs low, provide an excellent student experience, and run their processes as efficiently as possible. RPA was regarded as a suitable solution to meet those goals, and the management agreed to conduct a pilot study in 2020. This pilot study was initiated to test how RPA could be leveraged at the university, if the benefits could be realised, what issues might occur regarding integration with existing IT infrastructure and how those could be mitigated. For this reason, the RPA project was led by the IT Services division rather than being business led (EY 2016; Santos et al. 2019) . For the pilot project, the processing of school leaver applications for university admission was chosen due to its rule-based, repetitive and high-volume nature.

We conducted 13 semi-structured interviews with employees of the university and its RPA vendor between December 2020 and May 2021, after the bot went live. The participants include six employees from the Admissions team, including three Admissions Officers and the Admissions Manager, four members of the RPA project team, including the Developer, the Test Analyst, the Application Support Analyst and the Project Manager, two representatives from the RPA vendor, and the university project sponsor. Interviewing participants from all involved teams allowed us to capture a holistic picture and rich accounts of the entire RPA implementation lifecycle, the associated challenges, and the actions that were taken to mitigate those challenges. We achieved demographic diversity by interviewing six women and seven men from various cultural and professional backgrounds, with different tenures in the university and levels of RPA expertise. The interview guideline covered four main topics: a) a description of their current role and job satisfaction; b) their perception of the RPA implementation and the challenges that occurred; c) the actions and strategies that were taken to facilitate the implementation project; and d) the effects on the work practices and the processes. Each interview took 30-60 minutes, was conducted in person or via Microsoft Teams and was recorded and transcribed. After each interview, key insights were written down and periodically discussed within the research team.

The data analysis followed a two-step approach. In the first step, we conducted a thematic analysis (Braun and Clarke 2006). We read the transcripts again to familiarise ourselves with the data before coding the data inductively using initial codes.We then grouped the codes into themes, reviewed those themes and discussed if and how those themes are related to each other. Alongside the coding and theme development process, we produced memos with key insights. Each memo described and specified one theme, which supported the theorising process. In the second step, we identified socio-technical theory (Leavitt 1964; Lyytinen et al. 1996, 1998) as a suitable theoretical lens to assist us in the sense-making process and to explain the themes we found in the data in light of the research questions. Using abductive logic (Kovács and Spens 2005), we went back and forth between data and theory to identify: a) the major events and issues that occurred during the RPA implementation project; b) on which level, i.e. work system, project or organisational level, each issue or event occurred; c) which components of the socio-technical model used, i.e. technology, actor, task or structure, were involved; d) which strategies were applied to address the issue or event; and e) the associated outcomes of those strategies.

The following example describes how we analysed the data using key concepts from socio-technical theory. The data excerpt describes an issue that is occurring at the project level. In it, the developer is discussing how he needed to upskill in RPA development and contrasts it (unfavourably) with the type of programming he is used to: “It’s not really hard-core development. So, it's a new thing for me. I was out of my comfort zone.” Using the socio-technical components to guide our analysis, we identified a tension between the expectations of the developer (actor), his understanding of the norms of traditional “hard-core” development (structure), the newer development technique associated with software robots (technology), and the work he is required to undertake in the project (task).

4 Findings

Based on our data analysis we identified 20 issues or events in the project that we considered to be important in understanding the RPA implementation process. We grouped these into six distinct, but temporally overlapping, episodes, each based around a set of issues and events sharing a natural association. The structuring of our analysis into a sequence of episodes enabled us to better present a coherent process narrative. In practice, the RPA implementation process was not so linear, but complex and iterative, with some effects occurring across multiple episodes or changing over time. In each episode, we examine the content and context of each key issue or event in terms of the level on which activity occurred (organisational, work system or project), and the salient socio-technical components that we observed, including alignments and gaps between the actors involved, the tasks on which they were engaged, their interactions with the technology, and the influence of various structural elements. As close collaboration between the project team, business unit and management are required in RPA implementations, the issues often occurred over several levels at the same time. Our analysis includes the strategies that were applied in order to resolve each issue and the outcome of those actions. While some strategies were successful, others led to further issues or could not be resolved. The process narrative can be read alongside Table 1, which summarises the key aspects of our analysis.

4.1 Episode 1: Antecedent Conditions to Project

The IT Services division of the university has a culture of continuous technological advancement. This involves growing their own technical expertise by using new technologies to improve processes across the organisation. They saw RPA as an emerging technology that could be leveraged to automate mundane, repetitive and high-volume tasks performed by various administrative units. The CIO was convinced of the potential of RPA and set about enrolling the support of other senior university leaders The senior managers investigated a range of RPA products, vendors and use cases in different contexts, and became persuaded of the benefits afforded by RPA after seeing it in operation in another university. They made the decision to proceed further with implementing RPA in their own university.

The secondment elsewhere of the CIO during the COVID-19 pandemic meant that the IT Development Director assumed the CIO’s duties and became the RPA project sponsor. His first task was to acquire an RPA vendor, assemble a project team and identify a suitable pilot process to automate. Proceeding with RPA as a pilot project reflected IT Services’ approach of developing in-house technical expertise and meant that the project could be funded from the division’s existing budget. As the Acting CIO explained, the goal of the pilot project was to: “learn what bots are [and] that we have a feel for whether they would work in our environment … The return on investment … wasn't critical for moving to the next phase.”

4.2 Episode 2: Establishing the Project

The selected vendor was willing for solution development and implementation to be a collaborative process. This was compatible with IT Services’ goals and way of working. Having the IT Services team work closely with the vendor enabled them to learn how to develop and maintain software bots, acquiring the skills to trouble shoot and manage the technology themselves. Development of in-house expertise with RPA technology would also enable the scalability of RPA solutions within the university in the longer term: “They ended up working with us the way that we wanted to work with them, which was us doing the bulk of the work and them just upskilling us rather than doing the work” (Acting CIO).

The project team assembled by the Acting CIO comprised a Project Manager, Developer, Test Analyst (responsible for quality assurance of the RPA solution), Application Support Analyst (responsible for the compatibility of the RPA solution with the university’s operating environment), and two vendor representatives: a Relationship Manager and a Solutions Architect. Almost immediately, a problem arose with the Application Support Analyst assigned to the project. A high workload in other areas affected his ability to contribute to the RPA project. Eventually, he left the project team and a replacement was appointed. The new Application Support Analyst became committed to the project and was an important contributor to the project's success.

Ep	*Issue/Event*	*Level(s)*	*Component*	*Strategy*	*Outcome*
1	Identifying technologies to optimize processes	Organisational	Actors, Task, Structure	Monitoring the Gartner Lifecycle	Identification of RPA as a technology of interest
1	Evaluating feasibility of RPA in the organisation	Organisational	Actors, Task, Technology, Structure	Enrolling senior management support	Agreement to pursue RPA technology
1	COVID-19 pandemic diverts CIO to other duties	Organisational	Actors, Task, Structure	IT Development Director is acting CIO/project sponsor	RPA implementation proceeds as self-funded pilot project
2	Selecting vendor that fits IT Services strategy	Project	Actors, Task, Structure	Collaborating to build in-house expertise	Skill acquisition and scalability
2	Personnel issues arise in the project team	Project	Actors, Task, Technology	Decision to replace the original team member	New analyst committed to the project
2	Finding a suitable pilot process for the project	Work system Project	Actors, Task	Pitching RPA to administrative units	Admission process identified as RPA pilot
2	Admission team is overwhelmed by volume of applications	Work system	Actors, Task	Implement RPA to ease workload for team	Automating standard applications will reduce workload and stress
3	Project Manager has difficulties in managing project finances	Organisational Project	Actors, Task, Structure	Flow up with Finance office on multiple occasions	Effective management of the project finances, and resources
3	Offshore vendor and COVID-19 lockdown	Project	Actors, Task, Technology, Structure	Communication and collaboration via digital technologies	Development tasks completed online synchronously
3	RPA development differs from Developer's prior experience	Project	Actors, Task, Technology, Structure	RPA vendor provides guidance, templates and training modules	Developer upskilled and became familiar with RPA development
3	Resource constraints mean no full-time developer available	Project	Actors, Task, Structure	Logged as a risk but accepted as unable to be changed	Project delayed twice (but not significantly)
4	Managing the bot's limited capabilities	Work system Project	Actors, Task, Technology	Restricting bot usage to simple rule-based tasks	Human processing is needed to manage exceptions
4	Accommodating exceptions in the work process	Work system	Actors, Task, Technology	Allocating tasks between humans and the bot depending on skill set	Bot hands over tasks that are out of scope through reports
4	Delayed communication created concerns among the Admissions team	Work system Project	Actors, Task, Technology, Structure	Manager establishing regular communication, opportunity for input	Admissions team members felt heard and were less anxious about RPA
5	Integration issues with the Elbion system	Work system Project	Actors, Task, Technology	Building a grid filter so bot can access needed information	Required a change to the Elbion system; project delayed
5	Identifying a process efficiency	Work system Project	Actors, Task, Technology	Enabling the bot to access the Elbion database back end	Increased speed of process execution
5	Insufficient licenses to test the bot in the staging environment	Organisational Work system Project	Actors, Task, Technology, Structure	Securing additional funding to purchase a second bot license	Bot able to be tested in staging; project delayed
6	Regular Elbion releases will require ongoing adjustments to the bot	Work system Project	Actors, Task, Technology	Purchasing a third bot license specifically for testing	Insufficient resources preclude a dedicated testing license
6	Software robot performs slower than expected	Work system Project	Actors, Task, Technology	Bot scheduled to run in early morning when traffic on Elbion is low	Benefit of RPA is releasing staff for value-added work
6	Minor performance errors detected in production environment	Work system Project	Actors, Task, Technology	Reconfiguring the bot to correct detected errors	Some problems only detectable after bot runs on real data

Table 1. Analysis by Episodes

Several administrative teams in the university were contacted to identify a suitable process. The manager responsible for student admissions was eager for his team to be used as the pilot. This team processes online applications for admission to the university's academic programmes, and undertakes several processes that are mundane, repetitive and of high volume. The processing of school leaver applications was chosen for the pilot: "This seemed to be the simplest one to start off with and had the most impact because we are talking thousands of applications potentially that staff members won't need to actually touch" (Admissions Manager). The Admissions Manager and an Admissions Officer joined the project team to assist with data collection and user acceptance testing.

The process involves sending a provisional offer letter to potential students who have applied for admission to the university during their final year of school. Applicants may apply for a range of programmes at the same time, and some applications need to be handled differently depending on the programme that is applied for. The process requires running a report in Elbion, the student management information system, to identify school leaver applications; performing a series of checks, including with an external system; and generating a letter with a provisional offer of acceptance. Although it only takes an Admissions Officer 1-2 minutes to process each application, the very high volumes of applications received during a peak period between September and January often overwhelmed the Admissions team. This delayed agreed processing times, increased stress and the need for overtime, and prevented team members from taking annual leave over the summer period.

4.3 Episode 3: Developing the Bot

The Project Manager oversaw the project, managing the different stakeholders, coordinating project communication and meetings, and ensuring that tasks were completed on time so that the project remained on schedule. He encountered some difficulties with obtaining necessary information from the university's Finance office to manage the finance and resourcing aspects of the project. As the vendor was based offshore, collaboration with key members of the project team to build the bots took place online. This was less of an issue than might have been expected as a COVID-19 induced lockdown at the beginning of the project meant all work needed to be done remotely. The project team quickly realised that they could easily and conveniently collaborate online using Microsoft Teams. The Developer, Test Analyst, and vendor Solutions Architect held daily two-hour video calls to develop the bot. This meant that they worked on tasks together and ironed out any issues as they arose, mitigating the testing workload. The Test Analyst highlighted: "I was right there to help sort out the requirements. The more requirements you get sorted out, the least testing you have to do … It's built right to start with."

The Developer assigned to the project faced a steep learning curve. In contrast to his prior programming experience, he was heavily involved in data collection and requirements analysis and was responsible for writing most of the process documents: "As a developer we don't usually do documentation … That was a bit of a challenge." The vendor was supportive and provided document templates and advice as needed. There was also incongruence between the developer's prior experience the techniques used for software robot development. The Developer completed a series of RPA training modules and, with the help of the vendor, was able to upskill, gaining valuable experience and ensuring that the bot was produced to specifications: "I'm usually doing hard-core development. So, this one is a bit out of my area of expertise … I was out of my comfort zone." Although the vendor had asked for a full-time developer, this was not possible due to resource constraints. The Project Manager logged this as a risk, and in two specific instances the Developer was required to work on other projects, delaying the RPA project.

4.4 Episode 4: Managing Organisational Change

The project team decided to restrict the bot to straightforward rule-based tasks and avoid it processing complex applications or those requiring a large number of steps: "What we're looking at most for the bot is just the nice simple ones … We didn't want to make things too complex in the beginning" (Admissions Manager). While the bot could check applicants' school qualifications against preferential entry criteria, it could not accurately identify or evaluate uploaded files such as a driver's license or design portfolio. Human cognition is needed to process such applications. Despite limiting the bot to processing straightforward applications, its implementation was expected to make a significant difference to the workload of the Admissions team during its peak period. Although the Admissions Officers will not have to process the bulk of school leaver applications, they will need to learn to work with the bot, negotiating new boundaries between their role and that of the bot in the school leaver process. The main interaction between the bot and the human employees will be managing exceptions, which will be included in a report generated once the bot has completed its work: "The bot will just go through and then if it's not an application he can process, he will not process it any further. It will come [through] to the exceptions report" (Admissions Officer L). Specific tasks are then allocated to a limited number of the Admissions team to process manually based on the skill set available.

The Acting CIO did not expect the RPA pilot implementation to cause a large amount of disruption: "We're taking … a softly, softly type of approach. We are not anticipating any whole scale workforce changes … The people change management aspects … would be a reasonably minor part of the project." Nevertheless, managing the expectations of the Admissions staff who would be affected by the implementation of RPA in their area of work was important. However, the main Admissions team were not told of the decision to implement RPA until after the project was underway. Communication about the RPA implementation caused a degree of anxiety and uncertainty among some members: "What happens when it comes in? Will it actually help us or take away our jobs? Me, I had a bad feeling about it when I first heard of it" (Admissions Officer R). They were also given little explanation of how the bot works and what it would actually be doing. To mitigate these concerns, the Admissions Manager initiated regular emails to the Admissions team describing the project and its rationale, the vision and objectives for implementing RPA, and how it would affect them, including the impact on their jobs. In addition, team members who had concerns were generally comfortable presenting them to their manager. He tried to accommodate them where possible and his realistic and positive attitude towards the RPA implementation reassured most of the Admissions Officers: "Then I talked to my manager about it … [and] he was like hoping this RPA will help us in processing [applications] in a more efficient way … So, I wasn't too worried after all because it's in a positive way" (Admissions Officer R).

4.5 Episode 5: Integrating With Other Systems

To perform its tasks, the software bot needed to interact with Elbion, the university's student management information system. However, the bot was unable to recognise and penetrate certain controls that a human user would see as a drop-down menu. To accommodate the bot, a filter that the bot could read was built and added: "The product actually changed Elbion. We needed to put a … filter on a grid so that the robot could pick the right row" (Test Analyst). This issue resulted in a one to two-week delay in the project. However, process efficiencies were also made possible by the way that the bot could integrate with the Elbion system. For example, while Admissions Officers would use the user interface at the front end of the system the bot, instead of mimicking a human user, could access the database directly by connecting through the system's back end: "It's much more efficient to do, you know, but a human can't go and get into the database" (Vendor Solutions Architect).

Given the importance of its integration with the Elbion system, testing the developed bot before it went into production was a high priority. To provide access to Elbion, it was decided that the bot should be tested in the Elbion staging environment – a production-like environment where changes or updates can be tested before they are deployed. A single unattended robot license had initially been acquired for using the bot in the production environment. Now, a second license for a non-production robot would need to be purchased for testing the bot in the staging environment. Since the cost of the project was from the IT Services operating budget, there were limitations on available resources. Finding additional funds to pay for the license and the extra work done by the vendor resulted in a further project delay.

4.6 Episode 6: Managing Implementation Performance

Longer term, the Test Analyst was concerned about the practicalities of maintaining the bot under subsequent regular Elbion product releases. Her preference would be to conduct vigorous testing of the bot's integration with Elbion upstream in the Elbion test environment before any update to Elbion was handed over to the staging environment. Without this, if a problem occurred with the bot and a new Elbion release, the Elbion system would have to be restored to its original status until the bot could be fixed. However, testing the bot in the Elbion testing environment would require a third robot license, something IT Services did not currently have. The proposed solution was to find additional resources to fund a third license: "Get another license, [and] get the bot installed on an environment that I have more access over" (Test Analyst). In the meantime, the testing team will do their best to take care to avoid or iron out any issues potentially affecting the bot before a new release reaches the staging environment.

Once the bot commenced work, its output was monitored for any errors: "The bot will be online. He starts working, but even then, I have to check for the problems … to check if everything is correct" (Admissions Officer). This monitoring revealed a small number of issues that required technical adjustments to how the bot did its work. These highlighted the difficulties of testing the bot before its deployment in a live production environment, such as the use of dummy data sets in testing scenarios, rather than the real student data the bot would access in production. A further unanticipated issue was how the slow responses times for Elbion during business hours adversely affected the bot's performance when it was interfacing with the system. The bot became so slow that it was actually taking longer for the bot to complete its work than a human Admissions Officer would: "It's dependent on Elbion's performance as well. So, for example, if Elbion crashes then obviously the bot can't continue doing its work, or it times out, or something goes wrong" (Admissions Manager). To mitigate this issue, the project team decided to only allow the bot to work between 7 and 9am every morning before demand on Elbion increases. The Admissions Manager was not aware how the bot actually performed its tasks: "It's actually like someone's actually doing the work." This prompted him to see the benefit of RPA more in terms of removing mundane work, than saving time: "It's not about speed. It's just about why would we get someone to do this when there's not really any thinking involved?"

5 Discussion and Conclusion

The first research question of this study was: "How can RPA implementation be understood as socio-technical systems change?" Our analysis of RPA implementation shows how issues that occur during the project affect various components in the socio-technical systems at the project, work system and organisational levels. In line with Lyttinen and Newman (2008) we found that those issues could lead to a gap or misalignment between various components that required an intervention in order to be mitigated. For example, the Developer (actor) was unfamiliar with the development of software robots (tasks, technology), leading to a misalignment of the three components and the need to complete RPA training modules in order to close the gap and assure that the project success was not threatened.

We not only observed an interactive relationship between the different socio-technical components on one level but also complex dynamics between the different system levels. Actions that were taken or neglected in one socio-technical system often affected a socio-technical system on another level. For example, the delayed communication (task) about the RPA implementation (technology) from the project team (actors, project level) led to uncertainty and anxiety among the employees (actors) of the Admissions team (work system level). Additionally, issues that surfaced in one socio-technical system often could only be solved by making changes in a socio-technical system on another level. For example, the bot (technology) could not penetrate certain controls in Elbion (task), which was an issue identified on the project level. Therefore, changes had to be made in Elbion (technology) on the work system level for the bot to be able to access the required data. We thus contribute to the RPA literature and socio-technical theory by showing both the complex interdependencies between different socio-technical components in a RPA context and the interconnected effects of RPA implementation on different levels.

Exploring RPA from a socio-technical perspective, we found that software robots have a dual role as a technology-actor. Actors can be defined as organisation's members that carry out the work (Lyttinen and Newman 2008). Software robots take over work tasks that were previously executed by human employees and therefore meet the attributes of an actor. At the same time, bots are clearly a software tool, and possess the material attributes of a technology. We argue that as an autonomous technology, RPA leads to the blurring of the boundaries between what is traditionally considered actor-oriented and technology-oriented in IS development projects and work systems. Thus, the introduction of RPA into socio-technical systems increases the complexity of both a system and its analysis.

Investigating the dynamics within the new socio-technical system, including the technology-actor, we found that employees and software robots work collaboratively to complete the admissions process. To describe this relationship, we draw on the concept of hybrid intelligence (Dellermann et al. 2019). Hybrid intelligence unites the creative, empathetic, decision making and problem-solving skills that humans possess with the insentient nature of machines to execute tasks consistently, with speed and efficiency. It combines the complementary intelligence of both humans and machines to provide an output that is not possible for either humans or machines alone (Dellermann et al. 2019; van der Aalst 2021). In our RPA context, we translate the concept of hybrid intelligence into the allocation of tasks depending on the relative skillsets of human and technological actors. The bot processes the simple, rule-based and mundane applications, whereas human employees work on those that require human judgment and visual recognition – "tak[ing] the robot out of the human" (Lacity and Willcocks 2021, p. 170). This allows the bot-human team to process more applications in a shorter timeframe. Collaboration in such 'hybrid processing' allows humans and machines to augment each other and work in the most efficient way. Creating a socio-technical system centred on hybrid processing may foster a sense of trust and acceptance among humans as both employees and bots adopt specific roles within the automated process. As task and process automation is often equated with job loss, the concept of hybrid processing reinforces the notion that humans and machines can work together synergistically (Dellermann et al. 2019).

Davis et al. (2014) argue that the reinterpretation of socio-technical principles can contribute to addressing the challenges of contemporary IT. To answer our second research question: "What principles can be applied to increase the likelihood of RPA implementation success?", we outline in Table 2 eight key principles drawn from socio-technical systems theory (Clegg 2000; Davis 2019) that we suggest can be applied to RPA implementation projects based upon the findings of our study.

Socio-Technical Design Principle	*Applied to RPA Implementation*	*Example From Our Study*
Design is systemic (Clegg, 2000; Davis, 2019): components are inter-dependent and should be designed jointly. A change to one may have unanticipated consequences.	Consider how designing a change to one part of a system might require changes in other components or levels. Inter-dependencies may only be apparent when the system is in operation.	Demand for and ongoing changes to the Elbion system had impacts on the bot's performance.
Design should reflect the needs of the business (Clegg, 2000): A system should be implemented for a valid reason.	The validity and feasibility of introducing RPA within an organisation needs to be evaluated prior to implementing it.	CIO and senior managers evaluated RPA and its different use cases against the organisation's needs.
Systems and their design should be owned by their managers and users (Clegg, 2000; Davis, 2019): Socio-technical design requires users to participate in the design process and own the system.	The need to learn about the process to be automated emphasizes the importance of involving users in RPA design and implementation, and their subsequent appropriation of the technology in their work practices.	Admissions Manager and one team member joined the RPA project team. Other staff initially lacked clarity and trust in relation to how the bot would work.
System components should be congruent (Clegg, 2000; Davis, 2019): Any change to part of the system needs to be congruent with and support other components	RPA implementation can change the nature of work for employees. New working arrangements need to be congruent with affected employees' skillsets and their underlying values.	Admissions team members were reassured when they realised that the bot would only process high-volume tasks, reducing their stress
Design entails task allocations (Clegg, 2000): Socio-technical design involves multiple task allocations amongst and between humans and machines.	Humans and robot employees bring complementary skills and abilities to meet the requirements of a system. Task allocation between them should be explicitly addressed in a systemic way.	The decision to restrict the bot to simple rule-based tasks was deliberately made by the development team.
Systems should make problems visible (Clegg, 2000; Davis, 2019): Systems are most effective when they make problems visible and easy to resolve at source as they arise.	As operating conditions become more complex and less certain, it may be necessary for human decision-makers to intervene when problems occur in automated work.	An exception report captured unsuccessful processing cases, which were assigned to human team members to resolve.
Design involves multidisciplinary education (Clegg, 2000): Assembling people with different skills and experience to build a multi-disciplinary understanding.	Already having all necessary knowledge is rare. The vendor relationship is important. A Centre of Excellence ensures that knowledge and expertise is retained for future implementations.	The vendor allowed collaborative development. The project team acquired the skills and expertise to maintain independence.
Design is open-ended (Davis, 2019): Socio-technical design is an open-ended process. Constant change implies the need to continually review and revise designs.	The integration of RPA with existing processes and systems triggers a need for the ongoing reconfiguration of software robots as change occurs.	Developing in-house RPA expertise was critical for troubleshooting problems, maintaining the bot, and exploiting scalability.

Table 2. Socio-Technical Design Principles for RPA Implementation Projects

In conclusion, our study has two main limitations that need to be acknowledged. First, the data collection finished six months after the bot went live. Therefore, we can only report about the initial collaboration patterns between human employees and the bot. Further, research is required that explores how these patterns evolve over time. Second, the socio-technical design principles for RPA implementations were derived based on the insights of our case study. We do not claim that these are exhaustive and apply in all RPA implementation contexts. Therefore, we encourage further research to explore the applicability of those socio-technical design principles in other RPA implementation contexts and add to or adapt the existing framework as needed.

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