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# Early evidence of digital labor in accounting: Innovation with Robotic Process Automation

Julia Kokina *, Shay Blanchette

*Accounting and Law Division, Babson College, 231 Forest St., Babson Park, MA 02457, United States of America*

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Robotic Process Automation (RPA) is an emerging technology that enables the automation of rules-based business processes and tasks through the use of software bots. Drawing upon the theory of Task-Technology Fit (TTF) and Technology-to-Performance Chain (TPC) (Goodhue and Thompson 1995) and research on expert systems (Messier and Hansen 1987; Sutton 1990), this study explores emerging themes surrounding bot implementation for accounting and finance tasks. We collect and analyze interview data from adopters of RPA and document task suitability, task-technology fit, implementation issues, and resulting performance outcomes. We find that securing technical capability is only a part of RPA implementation process. Organizations engage in standardization and optimization of processes, develop scorecard-like tools to rank tasks, adjust governance structures to include digital employees, and redefine internal controls. Organizations benefit from automating only certain processes, those that are structured, repeated, rules-based, and with digital inputs. Along with cost savings, organizations experience improved process documentation, lower error rates, more accurate measurement of process performance, and better report quality.



## 1. Introduction

This paper is motivated by the need to more thoroughly understand the context surrounding the emerging implementation of robotic process automation (RPA) in accounting and finance. Although the topic of automation and the use of a virtual digital workforce in accounting have received a lot of attention in the popular press (Vipal, 2015; Agnew, 2016; Monga, 2017, Shumsky, 2017a, 2017b), little is known about the adoption of this transformative and disruptive technology and the organizational implications surrounding the implementation of RPA for accounting and finance tasks.

On the one hand, RPA implementation has been shown to decrease time and cost of data processing and improve process accuracy, consistency, traceability, and decision quality (Ernst and Young (E&Y), 2016, 2017c). On the other hand, some sources have documented limitations and risks associated with RPA implementation by noting an initial RPA project failure rate of 30 to 50% (E&Y, 2017a) and expressed concerns over the fact that organizations often do not assess potential risks and lack appropriate RPA-specific governance mechanisms and strong internal controls (Pricewaterhousecoopers (PwC), 2017a). Other sources point to difficulties with RPA scaling and change management (McKinsey&Company, 2017). Therefore, it is important for both accounting academics and practitioners to evaluate the benefits as well as some potential risks of RPA implementation. As a result, the current study attempts to make the following two contributions to the accounting information systems literature: (1) to understand the issues associated with the digitalization of accounting and finance processes, and (2) to inform and guide future research in this area of accounting innovation.

* Corresponding author.
*E-mail addresses:* jkokina@babson.edu, (J. Kokina), sblanchetteproulx@babson.edu. (S. Blanchette).

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As RPA initiatives in some organizations, especially those in financial services, move beyond exploration to implementation (PwC, 2017b), this offers a timely opportunity to collect initial empirical evidence of digital labor use in accounting and to identify emerging themes surrounding RPA implementation and to inform relevant research in this area. As indicated by every survey respondent, operations and finance are two areas where the benefits of RPA implementation outweigh the costs (PwC, 2017b). A recent Deloitte survey reports that 53% of participants have begun their RPA implementation journey with 19% expecting to adopt RPA within the next two years, with almost universal adoption within five years (Deloitte, 2018b).

The analysis presented in this study seeks to identify accounting and finance task suitability for RPA, task-technology fit, issues encountered when implementing RPA, and performance impacts of RPA. Thus, we focus on the following research questions:

- **Task suitability for RPA:** What are the characteristics of tasks that could be automated using RPA? In which accounting or finance processes or tasks has RPA been implemented? Why were those processes chosen? For those areas evaluated, but not selected for automation, why were they not chosen?
- **RPA implementation:** What motivates companies to adopt RPA? What were some of the implementation challenges? What process was used to assess the risks associated with RPA? What governance structures were deployed to facilitate RPA implementation?
- **Performance impact:** What has been the quantitative and qualitative performance impact of the RPA implementation?

The current study adopts an exploratory approach and presents an analysis of semi-structured interviews with RPA adopters and providers from organizations representing different industries and sizes. Where possible, information obtained from interviews is corroborated with organizational documents and materials in order to achieve stronger substantiation of our analyses and findings. Due to the exploratory nature of this study, our interview questions centered on general themes and follow-up questions were developed during the interviews.

The relevance of this study is evidenced by a call for research outlined in Moffitt, Richardson, Snow, Weisner, and Wood (2016, 168) who state that "the ramifications of computerization and automation within accounting and our broader society are potentially quite dramatic and excellent areas for research." In addition, they note that researchers should engage in projects that identify accounting processes in which human involvement can and cannot be eliminated (Moffitt et al., 2016). Moreover, Sutton, Holt, and Arnold (2016, 68) urge AIS researchers "to provide leadership in new technologies that the profession is still rather ill-equipped to address and utilize."

This paper is structured as follows: the next section provides an overview of automation in accounting outlining where RPA fits in the cognitive technology landscape and a review of relevant literature. The following section describes research methodology and the context of the current study. The last two sections provide analysis of the results followed by a discussion and suggestions for future research.

## 2. Literature review

### 2.1. Robotic process automation

Robotic Process Automation (RPA) market estimated to grow to $2.9 billion by 2021 from $250 million in 2016 (Le Clair, 2017a). RPA is defined as "the automation of processes mimicking human interaction using technology to reduce manual intervention and low value human touches in auditable and controlled manner" (E&Y, 2017b). RPA employs software bots that can be thought of as "digital workers" each using its own computer station, username, and password similar to a human employee. Once a bot performs as many processes as it is able to within a twenty-four-hour period, an additional bot is needed to perform additional tasks. The RPA software product landscape is dominated by three companies: UiPath Inc., Blue Prism Group PLC, and Automation Anywhere Inc. (Winkler, 2018).

As presented in Kokina and Davenport (2017) and conceptualized in Davenport and Kirby (2016), cognitive technologies can be differentiated across two dimensions: *intelligence autonomy* and the *types of tasks* the technology is able to perform. Intelligence autonomy ranges from technology responding to human instructions to developing its own objectives that is a capacity that exists only in theory at the moment. The types of tasks range from numerical analysis typically organized in rows and columns to digesting images, to performing digital and physical tasks. RPA can be found at the intersection of repetitive task automation and digital task performance. Processes most suitable for RPA are rules-based, repetitive, do not require frequent changes, and are mostly free of exceptions (Deloitte, 2017).

RPA has evolved from desktop automation (DA) centered around macros focused on performing a single task using structured data (E&Y, 2017b). Unlike macros, RPA bots can interact with multiple systems, work autonomously and perform routine tasks consisting of binary decisions that do not require intelligence. More sophisticated RPA evolves into cognitive or intelligent automation (IA) that is capable of performing non-routine tasks involving judgment based on unstructured data.

Because many areas in finance and accounting involve tasks that interact with several systems, contain high levels of transaction processing, and require few decisions to be made, the potential for RPA use in these domains is high (Le Clair, 2017). Even though RPA has received a lot of attention in the business community, little is known about issues and context surrounding actual RPA implementation for finance and accounting tasks, including the methods organizations use to determine which tasks or processes should be automated.

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### 2.2. Expert systems research in accounting and theoretical links – matching tasks to systems

To conceptualize task suitability for RPA, it is important to establish links to the literature, especially studies that explore mechanisms through which accounting-related tasks, or problem domains can be matched to appropriate technology, expert system, or decision support system. Exploration and identification of characteristics of tasks that determine their suitability for a particular system is valuable because it is foundational to system implementation success (Sutton, 1990, 77):

> Chances for successful ES [expert system] implementation are improved by analyzing tasks that could be considered for ES development based on attributes that would be desirable in a good ES problem domain. This implies that successful ES implementation relies partially on identification of tasks having these desired attributes.

Some of the early work in accounting systems has focused on examining ways of finding a fit between decision aids and problem domains. Messier and Hansen (1987) classify audit problem domains as structured, semi-structured, and unstructured, and match them to the corresponding decision aids such as questionnaires, computerized audit software, and expert systems. With a particular focus on expert systems, Messier and Hansen (1987) highlight conditions necessary for successful development and implementation of an expert system, and identify challenges with knowledge acquisition and determining the quality of expert system judgments. They also emphasize that not all problem domains might be suitable for an expert system, and that available expert systems have significant limitations (Messier and Hansen, 1987).

Unlike Messier and Hansen (1987) who focus on reviewing existing audit expert systems under development, Sutton (1990) develops a framework for matching an audit problem domain to a knowledge representation (KR) technique. Sutton (1990) matches twenty six specific audit tasks to one of the two KR techniques: either a rules-based system or semantic network and frame, through seven factors (e.g., well-established routines, decision reoccurrence, surface or deep knowledge, size of decision domain). Sutton (1990) finds that more than half of the twenty-six analyzed audit tasks are suitable for a rules-based technique. The framework was designed to serve as a preliminary theoretical basis for KR technique determination. A more in-depth exploration of audit tasks is conducted by Abdolmohammadi (1999) who provides a descriptive database of 332 audit tasks categorized as structured, semi-structured, or unstructured, along with a corresponding decision aid for each task. Decision aids are categorized as follows: (1) complete automation – for tasks such as recalculation and footing, tasks that can performed entirely by a computer; (2) decision support systems (DSS) – interactive software tools that can assist with statistical models; (3) knowledge-based expert systems (KES) – interactive software tools that use 'if-then' decision rules to present recommendations to the user; and (4) human processing – for tasks that are not appropriate for automation, DSS, or KES. The findings of audit task analysis indicate that the majority of audit tasks can be classified as structured (39%) and semi-structured (41%) which makes them suitable for the use of technology (Abdolmohammadi, 1999).

Even though these studies focus on audit tasks, this study's focus is on accounting and finance tasks performed to prepare financial statements in organizations. This study draws upon the idea of matching task characteristics to decision aids (Messier and Hansen, 1987), finding how tasks correspond to knowledge representation techniques (Sutton, 1990), and matching tasks to decision aids (Abdolmohammadi, 1999) to determine the characteristics of accounting tasks that make them suitable for automation through RPA software tools. Moving beyond task characteristics, the purpose of our study is to explore RPA implementation landscape that has emerged in organizations similar to Rikhardsson and Kræmmergaard (2006) who find that an enterprise system can be viewed as an organizational actor that has an influence on organizational culture and processes.

### 2.3. Task-technology fit and technology-to-performance chain

Our goal is to document early indicators of RPA-related individual and organizational performance drawing upon theoretical links to the theory of Task-Technology Fit and Technology-to-Performance Chain (TPC) (Goodhue and Thompson, 1995) that connect characteristics of tasks and technology to performance through the construct of task-technology fit (TTF). TTF broadly applies to any setting in which individuals employ technology to complete specific tasks (Maruping and Agarwal, 2004) and focuses on matching the functionality of technology to the requirements of the task (Dishaw and Strong, 1999). As a theoretical construct, TTF is still evolving and has been operationalized differently in various studies. Some studies (e.g., Klopping and McKinney, 2004; Fuller and Dennis, 2009) adapt TTF items from Goodhue and Thompson (1995) who conceptualize TTF alongside eight dimensions – quality, locatability, authorization, compatibility, production timeliness, systems reliability, ease of use/training, and relationship with users. Other studies develop their own measures of the TTF construct. For example, Dishaw and Strong (1999) directly compute TTF by matching task characteristics and tool functionality, and Junglas et al. (2008) operationalize TTF as a trichotomous variable as ideal fit, over-fit, and under-fit all derived from experimental manipulations. In the context of the current study, we conceptualize TTF to represent a degree to which RPA software tools are able to automate and perform tasks that were formerly performed by humans. Because RPA implementation is in early stages at the time of this study, our goal is to explore and document initial components of RPA-related TTF.

The remaining components of the TPC are task characteristics, technology characteristics, utilization, and performance impacts (Goodhue and Thompson, 1995). In the context of RPA implementation, we view task characteristics as task attributes that make a task suitable for automation with RPA software tools, and technology characteristics are held constant as RPA software tools used - tools developed by UiPath, Automation Anywhere, or Blue Prism. Utilization is also held constant as the use of one of the RPA software tools was a requirement for this study. Performance impact is conceptualized as a mix of perceived and realized quantitative and qualitative impacts on both individual and organizational performance. Finally, in addition to documenting characteristics of task, task-technology fit, and performance, the goal of the paper is to identify emerging themes surrounding early RPA implementation for accounting and finance tasks in organizations.

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## 3. Research method and study context

Similar to Rikhardsson and Dull (2016), we adopt a multiple case study methodology to collect data for this study, a method that, along with cross-sectional field studies, is positioned between case-based (in terms of depth) and survey research (in terms of breadth) (Lillis and Mundy, 2005). Multiple case study approach allows us to take advantage, to some extent, of the breadth feature of surveys and the depth feature of a case study, with closer proximity to a single case study than a survey (Lillis and Mundy, 2005). This design is appropriate given the novelty of the research area (Eisenhardt, 1989; Lillis and Mundy, 2005) as the implementation of RPA in accounting and finance is an emerging area with most companies still rather early in their adoption journey or in planning stages of adoption. Specifically, some estimate that 37% of organizations were conducting RPA-related exploratory research and 51% were engaged in initial vendor and business case assessment, with only about 12% of companies conducting pilot and actual bot deployments (Le Clair, 2017).

Our study draws upon RPA user experiences and reflections captured through semi-structured interviews conducted in a small sample of organizations from different industries that have implemented RPA to automate accounting tasks. Even though this approach generally restricts generalizability, we conducted follow-up interviews and performed document reviews, where possible, to strengthen and corroborate our findings. In addition, we analyze data from RPA use cases presented at the global conference organized by one of the major RPA software providers. Including multiple organizations in the study has enabled us to identify cross-case patterns which would not be possible if we conducted a single in-depth case study (Lillis, 2002).

As part of the screening process, we established the following criteria to select participants for this study: The first criterion was that respondents had to have first-hand experience with RPA implementation in their organization using either UiPath, Blue Prism, or Automation Anywhere RPA software platform. The second one was that RPA was considered for use or already used for accounting and/or finance tasks, with broader RPA adoption preferred but not required. To recruit potential study participants, we identified two sources: (1) one of the largest RPA software providers in the world, and (2) an international organization of financial professionals.

Through the RPA software company, our first source, we connected with Company A - an organization headquartered in Central Europe because of the company's experience with RPA implementation for accounting and finance tasks. The organization is a partner of the RPA software company servicing clients in areas of business process outsourcing (BPOs), and companies in financial, telecommunications, and utility sectors, with a majority of their clients in shared services centers (SSCs), with a substantial portion of their practice dedicated to automation of accounting and finance tasks through RPA. Since inception, Company A has completed more than one hundred robotic projects and automated more than four hundred processes for more than thirty of its clients. Two semi-structured phone interviews with the organization's managing director and founder and a staff member directly involved with client engagements were conducted. We also received various internal documents including – Excel and Word documents listing RPA benefits, challenges, process selection scorecard, proof-of-concept examples and weekly status report, as well as various PowerPoint presentations about Company A, RPA, and processes they have automated and an employee implementation video from Company B. The RPA software company also connected us with Company C. We interviewed its Director of Financial Systems who leads the RPA Center of Excellence as part of the corporate financial planning and analysis department of a global beverage producer.

To gain access to more companies that use RPA, we approached our second source, a local chapter of an international organization of financial professionals. We recruited two organizations to participate in the study. The first participant is a Fortune 100 financial services organization (Company B). We conducted four semi-structured phone interviews: one with the Director of Client Systems Development who oversees robotics for the entire organization, the second one with the Director of Global Corporate Solutions Technology who is directly involved with robotics in accounting and finance areas, has been with the organization for 17 years and manages a team of 200 people. He is responsible for finance and actuarial applications, data management and delivery of analytics for all corporate systems, legal compliance, and quality control for all applications. The third interview was with the Lead Quality Manager of Global Corporate Solutions Technology who oversees the RPA Center of Excellence (CoE) and works directly with the accounting group to facilitate RPA implementation and oversight. The fourth interview was conducted with three members of the accounting group directly involved in RPA implementation. The second participant is a privately held technology company headquartered in the U.S. with a Japanese parent (Company E). We conducted one in-person interview with the organization's Senior Director of Finance and Administration who was in the process of implementing RPA.

To gain access to Company D we used a known sponsor approach as one of the authors had access to a senior manager involved in RPA implementation. Both members of the research team were present during the majority of interviews, participated in the interview process and took detailed field notes. Table 1 provides an overview of the organizations and interviewees who participated in the study (Panel A) and an overview of organizations that presented their RPA use cases at a global conference organized by one of the major RPA software providers (Panel B). Company C both presented at a conference and was interviewed separately for this study. All interviews and presentations were recorded and transcribed verbatim. Data collection took place between November 2017 and December 2018 (Table 1).

## 4. Results

Following Miles et al. (2014), we used a descriptive coding approach to data analysis. We used NVivo qualitative data analysis software to code and conceptually group the data into themes. We present thematically organized quotes along with the open codes in Appendix B, Panels A through I.

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**Table 1**
Case company overview.

| Interview No | Company | Interviewee | Interviewee Code | Years of Professional Work Experience | Company Size (Employees) | Industry |
|---|---|---|---|---|---|---|
| Panel A: Interviewee overview. | | | | | | |
| 1 | Company A | Managing Director | 1A1 | 19 | < 100 | RPA services provider |
| 2 | Company A | Managing Director | 2A1 | 19 | < 100 | |
| | | Head of Business Development/RPA Academy Training Lead | 2A2 | 14 | | RPA services provider |
| 3 | Company B | Director of Client Systems Development | 3B1 | 24 | 17,643 | Fortune 100, financial services |
| 4 | Company B | Director of Global Corporate Solutions Technology | 4B2 | 15 | 17,643 | Fortune 100, financial services |
| 5 | Company B | Lead Quality Manager of Global Corporate Solutions Technology | 5B3 | | 17,643 | Fortune 100, financial services |
| 6 | Company B | Senior Director of Sourcing Operations | 6B4 | 18 | 17,643 | Fortune 100, financial services |
| | | Senior Manager of Business Metrics and Technology, Finance and Actuarial | 6B5 | 8 | | |
| | | Senior Accounting Operations Reconciliation Analyst | 6B6 | 14 | | |
| 7 | Company C | Director of Financial Systems – Robotic Process Automation, Corporate FP&A | 7C1 | 17 | 9,600 | Fortune 500, beverages |
| 8 | Company D | Senior Manager of Finance Operational Excellence | 8D1 | 24 | 32,000 | Fortune 500, medical products and equipment |
| | | Senior Manager of Finance Robotic Process Automation | 8D2 | 18 | | |
| 9 | Company E | Senior Director of Finance and Administration | 9E1 | 27 | 1,225 | Product sales and support services |
| *Panel B: Supplementary case presentation overview.* | | | | | | |
| Case Presentation No | Company | Case Presenter | Case Presenter Code | Years of Professional Work Experience | Company Size (Employees) | Industry |
| 10 | Company C | Director of Financial Systems | 10C1 | 17 | 9,600 | Fortune 500, beverages |
| 11 | Company F | VP Finance Global Financial Solutions Shared Services | 11F1 | | 92,400 | Fortune 100, pharmaceuticals |
| 12 | Company G | VP of Innovative Automation and Banking Services | 12G1 | 20 | 85,000 | Financial services |
| 13 | Company H | Director of Strategic Initiatives | 13H1 | 20 | 7,400 | Fortune 100, diversified financials |
| 14 | Company I | Director, Enabling Technology | 14I1 | 19 | 135,100 | Fortune 100, pharmaceuticals |
| 15 | Company J | VP of Intelligent Automation | 15J1 | | 9,047 | Insurance, asset management |
| 16 | Company K | Transformation Director | 16K1 | 20 | 14,000 | Information Technology |

We have structured our analysis in accordance with TPC as follows: first, we address task characteristics (Appendix B, Panel A); then we identify relevant components of TTF by discussing six themes we identified when we analyzed RPA implementation (Appendix B, Panels B through G: motivation to implement RPA, initial RPA implementation, RPA implementation challenges, RPA implementation risk and control environment, RPA implementation organizational governance structure, and bot onboarding); finally, we focus on performance impacts (Appendix B, Panels H and I: quantitative performance measurement, and qualitative performance).

### *4.1. Task suitability for RPA – Appendix A and Appendix B, Panel A*

While Goodhue and Thompson (1995) operationalize task characteristics in terms of task equivocality (i.e., dealing with non-routine business problems) and task interdependence (i.e., dealing with more than one business function), task characteristics that relate to RPA implementation could be expanded to include task dimensions identified below. Based upon the interviews and the materials we have reviewed, consistent themes about the characteristics of tasks have emerged. Company A emphasized that the nature of the process determines its suitability for RPA, not where the process is occurring. Tasks that are labor intensive, repetitive, high volume, rules based, in digital form using multiple systems and structured data are strong candidates for automation with RPA. Furthermore, tasks that require little human interaction to make decisions or tasks that do not require judgment throughout the process tend to be easier to automate. Company A stressed that processes that interact with several systems are particularly suitable for RPA and processes that are repeated by several people, if automated, result in greater cost savings. Processes with paper inputs and processes that interface with external applications that tend to change are less suitable for RPA

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(Company D). In addition, Company A identified fragmented processes to be one of the biggest barriers to automation (e.g., invoice processing performed differently for each country).

Interestingly, Company D has observed that occasionally process owners reported applying judgment when processes were actually rules-based and could be automated. To assist with determining whether a process is a candidate for RPA or simply process improvement, many organizations have internally developed decision aids such as business case templates, process analysis toolkits, and scorecards. As a result, process screening for automation requires collaboration between process owners, the accounting and finance department, IT, and internal audit.

To document accounting and finance tasks that have been automated with RPA, we present Appendix A, Panels A, B, and C where we organize accounting tasks by three areas: order-to-cash, procure-to-pay, and report-to-record. Within each area we then summarize what the bot is performing based on our interviews and the documents obtained from organizations we interviewed. This list is non-exhaustive, but it showcases ways in which common accounting tasks can be automated with RPA. Using Deloitte (2018) categorization of what an RPA bot can do, our analysis suggests that even the simplest of bots are involved in multiple tasks (i.e., reading an email, copying data into a form based upon described decision rules, accessing the enterprise system to write to databases and then sending an email to solicit human input). It appears that as users gain comfort with the RPA technology, they are allowing the bots to perform a wide variety of tasks when infrastructure supports it. This allows the utilization of the bots to reduce human interaction and to gain further efficiencies throughout the process. It is clear that bots are being given access to enterprise systems in large number of tasks (38/39), demonstrating the comfort companies are finding with the security of utilizing a bot. Furthermore, more than half of the tasks we analyzed (22/39) involve opening, reading or creating emails and more than half (20/39) allow the bot to request human input.

The three task categories that were least represented are collecting statistics, making calculations, and pulling data from the internet. While we understand organizations are tracking bot KPIs (i.e., transactions processed, downtime, etc.) based upon our analysis, we saw limited examples of bots collecting statistics within the organization. Making calculations was used sparely. Part of the reason for this may have been that many of the tasks in Appendix A required the bot to fill out a form or an Excel template. The calculation may have been made when the form or Excel was completed and therefore was not viewed as the bot performing the calculation. Lastly, pulling data from the internet was a function that was utilized much less than the other task types. This was consistent with what we heard many of the interviewees say about having the bots using external data. They discussed challenges faced associated with bots breaking when external websites made changes to their site. As a result, several of the interviewees said they would use external sites in a much more limited way.

Company A's work with shared services centers reveals that among order-to-cash processes areas best suited for automation are quotation and order management, customer invoicing, customer master data management, and cash applications. Areas least suited for automation are credit and collections management. Among procure-to-pay processes, areas best suited for automation are vendor data management and supplier payments, while verification and approval, invoice processing, purchase order processing, and discrepancy resolution are least suited for automation. Reasons for low automation suitability were process dependency on scanned image interpretation, lack of integration with OCR, and task components requiring judgment and analysis.

Companies in our sample began their RPA journey by selecting processes that were important to their organizations, yet simple and low risk in order to gain confidence with RPA and prepare for scale-up. For example, Company D developed a bot for invoice retrieval during state audits. The bot eliminated the need to manually pull invoices from the ERP system thus saving time and enriching the work lives of process owners. Further, Company D automated reconciliation reviews for consolidations team, monthly and quarterly result presentation for FP&A team, and tax payments for the treasury. Company C started with journal entry processing, particularly intercompany journal entries. Company G began with back-office processes and gradually moved to a customer-facing process in which a bot assembles materials based on customer meetings scheduled in the calendar. Company B began its RPA journey in finance and accounting by automating contract management on the procurement side, specifically, their services procurement area and it was planning on automating all reconciliations and activity around entering payments.

Overall, accounting and finance processes in organizations present a ripe opportunity for RPA. Even though opportunities are vast, it is important to have a careful assessment process in place to avoid excessive bot maintenance (Le Clair, 2018) and implementing bots with limited benefit to the organization.

### *4.2. Motivation to implement RPA – Appendix B, Panel B*

Company K decided to pursue RPA because business users needed a cheaper and faster solution to implement changes in certain applications such as NetSuite and Workday. The alternative is to rely on IT which is cumbersome and resource-intensive (Company K):

> “I'm going back to heavy lifting, I've got to write code and I've got to spend several months trying to test new changes in these applications, build integrations - an expensive and time consuming process. That was the point that actually it's like I could just have a robot do this, I could have it up in a couple of weeks and I wouldn't need all this complexity and all this cost”.

Some organizations have ERP systems that are customized and making changes through IT takes too long even for a small change (Company D):

> “That was one of the features of RPA that we really liked as an organization, as a finance organization, because our SAP is old and it's heavily customized. Anytime a user wants to change something in SAP the typical response that they would get from IT is that'll be a year and a million dollars. So, even a simple thing could take a very long time and cost a lot of money”.

Another reason for RPA implementation is error reduction in their processes because bots can perform non-cognitive tasks with greater accuracy than human employees (Company A; Company G). Organizations turn to RPA also because they seek to enrich the jobs and improve retention of their employees by freeing them from manual tasks in favor of high value activities (Company B). Initially we expected companies to state that headcount reduction was a motivating factor; however, our interviews do not seem to confirm that. Rather, accounting and finance departments' workload is increasing due to growth and compliance, yet companies want to keep their headcount and costs flat (Company D). Finally, bots offer greater throughput than human workers and are available around the clock (Company G). To summarize, organizations' motivation for implementing RPA varies, however, providing employees higher level work and a desire to increase efficiency and improve effectiveness of processes was consistent.

In terms of TTF, as developed by Goodhue and Thompson (1995), we can identify *authorization* as a motivating factor of RPA implementation as organizations express the need for faster and less costly ways to make changes in their systems. Authorization refers to an individual's ability to obtain access to necessary data. In the context of this study, authorization can be thought of as ability to access and make changes to systems with less dependence on IT departments. If obtaining authorization to make code changes outside of IT is too cumbersome, RPA performance is likely to decrease.

### *4.3. Initial RPA implementation – Appendix B, Panel C*

Company A describes the implementation process as one consisting of five stages: process selection, process automation, process running, process monitoring, and exception management. Initial RPA implementation, however, typically begins with an organization selecting their preferred software vendor and a partner organization that consults on the technical aspects of RPA in addition to setting up organizational structure for RPA governance and oversight such as the Center of Excellence (CoE). The partner organization then prepares a proof-of-concept (PoC) to demonstrate how RPA software works typically by automating a process that is simple yet important to an organization, one that, if automated, will generate meaningful savings, one that does not require prior standardization (i.e., does not use inputs from different forms) and one that interacts with several systems (Company A). This is done before software licenses are purchased. One area that is typical for PoC is master data management, which could be vendor master data or customer master data (Company A).

As Company C reports, initial bot design begins by documenting the process ‘as is’ in a flowchart which is followed by creating a future state of the process. This is a collaborative effort between the technical accounting group, whose focus is on financial controls and risk, internal audit, IT security, data security, and the RPA center of excellence. At this stage, the process is scored and it is determined whether it is suitable for RPA or another IT tool.

Before automating a process, it is important to examine if it can be improved or standardized in some way. Company D through RPA implementation discovered that some of their processes were less standard and required more manual interventions than they previously thought. Company C expressed the need for pre-automation process improvement in the following:

> “If you automate a bad process, you'll just be automating errors. So, it's really important to make sure that you clean up the processes first and not rely on RPA to fix a bad process for you”.

Company D also discovered how important it is for process owners to identify every possible decision point occurring in their processes and to communicate those decision points to bot developers so they could build in as much error-handling into their code as possible. A respondent from Company D stated:

*“There is no decision too small for you to tell us about when you're going through your process”.*

Instead of automating a process from beginning to end all at once, Company J employed a ‘test, learn, and adjust’ model for initial RPA implementation. Their approach was to treat each bot as a new digital worker (Company J):

> “Let's get them into the production environment, let's monitor them while they're in that production environment and when we get confident in it and what they could do let's add additional skills to that bot”.

We have found many of the RPA implementation steps to be consistent between organizations. Use of Centers of Excellence provided success in standardizing bot protocols and replicating bot activities in other areas. Furthermore, the use of proof of concept to showcase quick wins was important to gaining traction for more widespread adoption of RPA. Finally, standardization and improvement of processes prior to developing the bot can improve bot performance and reduce exceptions.

In order to implement RPA, process standardization and a detailed understanding of decisions made within the process are critical. A component of TTF that is most relevant to these issues is *compatibility* which refers to standardization of data or ability to compare data without inconsistencies (Goodhue and Thompson, 1995). If a process is low on compatibility, such as invoices received from different countries, RPA performance could be negatively impacted.

### *4.4. RPA implementation challenges – Appendix B, Panel D*

One of the greatest challenges companies in our sample encountered when implementing RPA was the level of complexity associated with the need to document a process at a granular level of detail. Company F explains this realization in the following:

> “The one big surprise for us was really the level of complexity. […] We thought one of our strengths was that we had built standard processes with various financial activity across the multiple sites and we did, at about a 5000 foot level. When you get down to a keystroke level, we were not the same”.

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Company K recounts their challenge with employees outlining the "unhappy path" – the failures that could occur in each part of the process:

> "I think what we hadn't understood at the time is just how much business effort it takes to support setting up the robots because you think about a robot taking an activity that the business does today. Well, tell me what you do? Okay, you know, it doesn't take very long. The challenge is very much looking at the unhappy path for every one of those situations".

Another difficulty with RPA that stems from the level of complexity encountered in RPA implementation is the realization that process owners who become bot managers need to possess technology-related skills to a much greater extent than the RPA software providers advertise. For example, Company B reports:

> *"They [RPA vendor and business partner] are saying that anybody who is good in Excel macros can do it [RPA]. To an extent, yes, but what we have seen practically with our business users are - this is not comfortable, you know, they are not good at coding. That's why we had to do lot of handholding and my true sense on this is it would be nice if a person has some programming background, some scripting background or some automation background to easily pick up".*

Similarly, Company D reports:

> "It's advertised like you don't need IT, you can just you know [how to] go build bots and run them, but it's not been like that at all. We've had a lot of IT help and support needed, more than we thought we would, and dropping an innovative new tool into the legacy environment and ecosystem of IT [...] it's been challenging".

A notable difference in RPA implementation is that it is not typically driven by an organization's IT department. Instead, it is usually driven by those involved in business operations, those who are directly involved in the process being automated – process owners. However, the technical complexity of RPA challenges organizations to think about the level of self-service to strive for while minimizing process owner dependence on IT who has limited capacity to move every RPA project forward and make every change necessary in a timely fashion. The benefit of automation begins to diminish with the amount of maintenance it requires. Company B addresses this challenge in the following:

> "How can I put this in the hands of the business user who is best suited to understand the process and make small pneumatic changes without having to knock the doors, open a technology, at the same time without risking the failure about bringing down the systems to its knees. That's where we are right now struggling".

Company D has thought extensively of how to reduce risk by becoming better at troubleshooting if a bot breaks. They have implemented an agreement with process owners that if a bot breaks and it is taking too long to identify the issue, a process owner would commit to performing the process manually to meet the deadline. In addition, Company D learned to split each process they automate into smaller pieces from a coding perspective to improve the flexibility and error-handling of their bots.

> "A bot could run for 18 hours and if it breaks on step 20 of 800 or if it breaks on step 790 of 800, you have to start the whole thing over and wait for 18 hours again, so chunking it up gives you the option to just – it gives you more flexibility".

Organizations need to be prepared for more complexity and should expect they will need assistance from IT as part of an RPA implementation. As accounting and finance teams move toward a self-service model, additional digital upskilling will be required in these teams. In addition, incorporating bot resiliency (ability to deal with failure and errors) into the initial design and automating smaller pieces of processes can significantly improve RPA performance.

Issues that organizations we interviewed have encountered during RPA implementation seem to relate to TTF components of *quality*, particularly *right data* and *right level of detail*, and *locatability* or ability to determine what data is available and where they are located. Another component of TTF that serves as a determinant of performance is *ease of use/training*. If the right elements of data at the right level of detail are not maintained, if data are not easily available, if RPA tools are not easy to use and if users are not able to access quality RPA training, RPA-related performance will be negatively impacted.

### *4.5. RPA implementation: risk and control environment – Appendix B, Panel E*

In some organizations, there is a perception that RPA exposes them to risk and weaknesses within the control environment. Company C states that there does exist a concern of someone obtaining bot credentials and having unauthorized access to ERP systems. Company D communicates a similar unease as follows:

> "We've also encountered some challenges when people have said, 'Well, it's a bot. I don't want to give you access, they could do crazy things in the system,' right. And we say no, it can only do what you program it to do. Here are the controls that we have in place. [...] Well, there was this perception that it could go rogue and do all sorts of unintended actions".

At the bot development stage there are other concerns that emerge. For example, understanding how to appropriately achieve the transfer of internal controls and processes from a human worker to a digital worker and determining how this information should be reported are areas that are important yet puzzling and not clear-cut for organizations. More specifically, RPA implementation presents a need to question and re-examine existing internal controls and reconsider their need. Company C recalls the following:

> "Automation has changed the way folks look at controls. Robots don't commit fraud. They're not malicious. Separation of duties means something different when it comes to financial systems. Getting that across is allowing folks to be more agile with our

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governance. Not 'no controls at all', but making sure that we're really addressing the risk. I remember one exasperating conversation where I'm trying to explain to someone from internal audit, like it doesn't matter this robot has these different roles in the ERP system. They can post and approve purchase orders and create them. That's a big 'no-no' for people. But I can separate that in three bots for you, but our developers could program the bots to collude. That's where the risk is. You're not adequately addressing it by just focusing on what you used to do in the past".

In order to gain comfort with the newly-established RPA environment and to set up appropriate governance structure, Company H developed a thorough understanding of each bot's risk by placing them in tiers to streamline the production of bots that are less risky.

> "We have found that there are some bots that do things that are inherently less risky than other bots and so we believe it's a good idea to tier them in such a way that those that are lower tier bots, those that simply go and grab emails or generate a report that don't have a higher level of risk that we can get those out to market a lot faster. On the other side, we have our more risky robots, those that touch our financial systems that can potentially have financial or reputational risk, those require a lot more rigor and due diligence and governance".

To establish a strong RPA control environment especially as organizations scale the number of bots in operation, Company D focused on developing RPA-specific preventive controls and thorough documentation including coding best practices. To design the controls as part of RPA implementation, Company D continuously engages its SOX team and internal audit team who focus on software development controls and process controls.

As organizations establish RPA-related internal controls, it is important to anticipate the needs of external auditors as they audit the work of both human and digital workers. In the course of the audit, process owners might state: "Oh, I didn't do that, a bot did that" (Company D). For this reason Company D emphasizes that the responsibility for internal controls rests with humans or process owners, not with bots. Only process owners are able to determine if the figures actually line up while employees on the IT side can only be expected to verify that the bot did what it was programmed to do (Company D).

RPA requires a new understanding of risk and internal controls by internal and external parties. Use of RPA does not increase overall risk within an organization as long as appropriate internal controls are put in place. Furthermore, profiling bot risk levels and establishment of preventative controls are an essential part of the RPA control framework.

A component of TTF that is not included in the Goodhue and Thompson's (1995) construct, yet important in RPA implementation are *internal controls.* Internal controls refer to ability to implement mechanisms that ensure reliable reporting, compliance with relevant regulations, and risk mitigation in RPA environment. If appropriate internal controls are not in place, users will not be able to rely on RPA output which in turn can negatively influence RPA-related performance.

### *4.6. RPA implementation: organizational governance structure – Appendix B, Panel F*

Digital worker implementation introduces the need for new elements of robotic governance to be created. Some organizations incorporate those elements into their existing governance framework and view it as part of their broader continuous improvement effort (Company I). Most organizations, however, develop a Robotic Operating Model (ROM) which is initially instituted through a centralized governance body such as the Center of Excellence (CoE). As RPA implementation expands, organizations move to a less-centralized or federated model of governance. This model keeps certain aspects of governance central (e.g., knowledge repository, coding standards, and sharing of best practices) while distributing control over RPA to various teams (Company H, Company D). Company A outlines some of the components of ROM in the following:

> "It means that you need to set up some technology infrastructure, you need to have your process pipeline management process, how to choose processes for automation, how to prioritize this, how to run a business case, how to develop the process, how to monitor the process, how to handle the issues. This robotic center of excellence or this robotic operating model it's about how to manage your robots in organization but not only focusing on the server itself but on all aspects of an organization".

*Governance* is another aspect of TTF that is not a part of the original TTF construct, yet central to RPA success. Governance refers to RPA tool's ability to meet its users' needs for accountability. Organizations should incorporate RPA governance policies in order to achieve RPA program success. Establishment of centralized or federated governance models will depend on structure of an organization and the stage of RPA implementation maturity.

### *4.7. RPA implementation: bot onboarding – Appendix B, Panel G*

Onboarding a bot involves steps similar to those used to onboard a human employee. Company B reports that they assign each bot a bot ID, register it in the application inventory system, document each bot's purpose, estimate its life span and document its purpose. Furthermore, each bot goes through a review of entitlements to establish appropriate access for the function a bot performs for the organization. As Company A and Company D report, having to assign each bot its ID and a service account confuses IT as this does not align with existing IT policy. In addition to granting each bot access to systems, each digital worker needs to be included in the broad organizational structure and assigned specific roles and responsibilities (Company A). In anticipation of having thousands of bots within the next few years, Company B uses a dashboard which serves as a central mechanism to display operational bots across the entire organization. Bot onboarding may be more complex than anticipated as a result of

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organizational IT and HR policies. Organizations need to improve documentation (organizational charts, job descriptions and responsibilities) for bots and for those humans managing them. Bot onboarding involves developing structures for bot management and governance; therefore, it seems appropriate to assign them to the *governance* component of TTF. Even though governance is not a part of the original TTF construct, it is an important part of successful RPA implementation.

### *4.8. RPA performance impact: quantitative performance measurement – Appendix B, Panel H*

Goodhue and Thompson (1995) conceptualize performance as the completion of tasks where better performance consists of improvements in efficiency, effectiveness, and quality. In RPA implementations, we document each of those categories of performance. Because RPA implementation is an investment, an important RPA performance indicator used by many organizations is Return on Investment (ROI) which is measured in a wide variety of ways. Organizations attempt to identify early indicators of RPA performance by quantifying some of the different benefits.

Many state that their goal is to transition their employees' tasks from manual to higher value tasks (e.g., analytical tasks and customer-facing tasks). As a result, Company D expresses its RPA impact in terms of labor hours saved. Company K looks to eliminate labor hours and effort with a long-term target of reducing the headcount of the temporary staff it currently employs. In addition to saving time spent on manual tasks, another impact of RPA is error rate reduction and improvement in process quality (Company A). Company G, because of the brand's focus on customer experience, measures ROI as hours given back to their customers or increased revenue. Company H focuses on bot utilization by measuring straight-through processing rate or how efficiently a bot runs without any intervention.

Some organizations target using RPA-related metrics in the long-term because in the short-term they prefer to focus on proper understanding of issues and provide time for adjustment. Company D expresses this philosophy in the following:

> “Let's not start with metrics, let's figure out what works first and then next year we'll look for more metrics in terms of uptime and downtime, […] what our outcomes were at the end of the month, did we have a green month where most of our processes were stable and we were able to provide the output that we said we were going to provide or were they yellow or were they red; did something fall out, we really weren't able to do it and we had to go tell the process owner, please go do this work”.

Company D also points out how imprecise the measurement of time saved truly is because it is difficult to establish a pure baseline of how long it takes someone to perform a task or a process. People have difficulty estimating and, if they do, they often underestimate their actual time spent. This can make the bot appear to be performing worse than a human. Importantly, Company D developed sensitivity around using the term “non-value-added” work as it could be perceived as demeaning and cause robo-anxiety.

As organizations proceed along their RPA implementation journey, they realize that the impact of RPA is multi-faceted, complex, and not easily measurable. Company I states:

> “The definition of value for us is evolving. And early stage it was very much anchored to a pure P&L impact associated with real savings and we're realizing that value is multi-dimensional”.

Echoing a similar sentiment, Company H states the following:

> “Companies that led with an ROI changed their minds. They always started with ROI but then what you find is that the initial investment that you're making, the time and money that you're spending on that it's not going to give you the ROI that you actually think it will when we actually put the numbers together and talked about that initial investment it was like a seven year ROI so that wasn't a great story to walk around with either. So, since then we've evolved into more of a ROI strategy and we've actually redefined what ROI means for us”.

Instead of using a single RPA success metric, Company H conceptualizes ROI in terms of hours saved, the use of those newly-found hours, and the risks that RPA helps mitigate (e.g., eliminating human errors, and improved process transparency through a complete audit trail).

Organizations are successful in achieving quantifiable returns; however, a single traditional quantitative measure of ROI is less relevant in RPA implementation. We have seen organizations use a broad range of quantitative success measures associated with RPA including hours saved, cost reduction, revenue generated, hours given back to customers, reduced error rates and bot efficiency. Organizations continue to experience challenges in return measures due to imperfect tracking mechanisms for hours and costs and motivation for human estimation error. Companies will need to continue to refine tracking methods and may consider process mining software to assist. Furthermore, communication and support from upper management to employees about the organization's motivations for RPA seem to reduce robo-anxiety.

### *4.9. RPA performance impact: qualitative performance – Appendix B, Panel I*

Organizations acknowledge that even if they decide not to pursue RPA, a particular process still benefits as pre-RPA work forces teams to question why this process is performed in a certain way and if it can be a candidate for continuous improvement (Company B). Another benefit of pre-RPA work is elimination or decommissioning of unnecessary processes, those that do not add any value (Company G). For processes that are automated, RPA offers improved visibility and measurement as every step a bot performs is recorded (Company A). As a result, RPA offers improved evidence, documentation, and support for audit and

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compliance (Company C) and risk minimization if a process helps to avoid issues or penalties (Company G). For organizations focused on transactional work such as shared services centers, RPA offers better management of peak times at period ends because bots can be scheduled to work around the clock (Company A).

Process owners, when asked to reflect on their experience with RPA, report that it forced them to understand their processes in detail and explain them to others (Company D). Even if time savings are not achieved in some instances, the fact that work is transferred from task performance to review is considered an important success for employees (Company D). Lastly, RPA offers an opportunity for process owners to be more agile by relying less on IT and implementing changes faster (Company A).

Implementation of RPA has provided a wide range of qualitative success to organizations. Employees improve their understanding of the organizations' business processes, change management skills and develop higher level job skills. Organizations also significantly improve their ability to provide an audit trail to outside parties through the use of RPA. Overall, if the appropriate tasks are automated and TTF components are considered and addressed, organizations included in this study experienced at least some performance improvement.

## 5. Discussion and conclusions

RPA has received much attention in the professional world and in the press, and many companies have already begun the RPA implementation journey. While some of these discussions seem to indicate that RPA is widespread throughout organizations, based upon our discussion with interviewees, broader implementation of RPA in accounting and finance tasks is still in the early stages. However, with the broader identification of tasks that can be automated and improvements of individual and organizational performance, a significant rise in adoption of RPA for accounting tasks is expected.

While the analysis has provided insight into several areas related to RPA implementation, the current study's limitation in that the sample size utilized for these interviews was limited. However, Company A provided insight based upon their experience working with over thirty clients and therefore provided a broader perspective on RPA implementation in many organizations within multiple industries. Furthermore, interviewees in this study had an average of 18 years of professional work experience. They reflected on their actual, not perceived, experience with RPA implementation. Future research could employ survey or experimental methodology to enhance generalizability of this study's findings.

Drawing upon the theory of Task-Technology Fit and Technology-to-Performance Chain (Goodhue and Thompson, 1995), our analysis of task characteristics informs that tasks that are labor intensive, repetitive, high volume, rules based, in digital form, using multiple systems and structured data are strong candidates for automation with RPA. Even the simplest of bots are involved in multiple tasks which most commonly are reading an email, copying data into a form, accessing the enterprise system to write to databases and then sending an email to solicit human input.

In terms of RPA TTF, we identified the following components: *quality*, particularly *right data* and *right level of detail*; *locatability* or ability to determine what data is available and where they are located; *authorization* which can be thought of as ability to access and make changes to systems with less dependence on IT; *compatibility* which refers to standardization of data or ability to compare data without inconsistencies; and *ease of use/training.* Central to RPA implementation are *internal controls* or ability to implement mechanisms that ensure reliable reporting, compliance with relevant regulations, and risk mitigation; and g*overnance,* which refers to RPA tool's ability to meet its users' needs for accountability. Both internal controls and governance are not a part of the original TTF construct, yet they are important to RPA implementation success. RPA implementation introduces the need for an organization-wide bot governance structure. Typically, organizations set up a centralized bot inventory and outline RPA-related best practices for better knowledge management. There is a perception that RPA creates risk and weaknesses in the control environment. As a result, RPA implementation requires a new understanding of risk and internal controls which must be addressed both by process owners and internal auditors. Organizations question how they can ensure a transfer of compliance from humans to bots as the process is not clear-cut.

To measure RPA performance impact, organizations develop ROI metrics which are quantified in a wide variety of ways. Early indicators of RPA-related performance impacts consist of improvements in efficiency (e.g., labor hours saved, reduction in temporary staff headcount), effectiveness (e.g., transition from manual, rules-based tasks to analytical, customer-facing tasks), and quality (e.g., error reduction, improvement in process quality). However, measuring hours saved might be biased as process owners can underestimate the time spent on tasks, and it is challenging to develop a baseline for overall capacity. Therefore, RPA value is multi-dimensional and evolving. Some qualitative RPA benefits are process improvement, elimination of unnecessary processes, and improved audit trail.

Our analysis reveals that organizations are challenged by RPA complexity associated with understanding a process at a keystroke level and outlining the failures that could occur at each part of the process. Organizations emphasize the need for process owners, including accountants, to be more tech-savvy and have better coding skills in order to decrease the reliance on IT for RPA support. RPA implementations seem to require much greater IT involvement than organizations initially anticipate. Despite the complexity of RPA implementation, we did not encounter organizations where RPA programs had failed or were abandoned. Instead, an organization may place a particular bot out of service if a task or a process is found to require excessive standardization and manual interventions. For example, Company D, an acquisitive company with worldwide subsidiaries, automated a monthly and quarterly results presentation where all numbers were pulled from the system into a PowerPoint template. They found that their processes were not as standardized and required significant manual intervention, especially as new acquisitions' systems required time to integrate. Furthermore, executives wanted to see data presented differently in the package as new companies were acquired. As a result of all of the required manual interventions, Company D chose to take the bot out of service. Even though

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initially the process was evaluated as suitable for RPA, performance of the bot was diminishing due to reductions in TTF caused by a widening gap between task requirements and the functionalities of RPA technology (Goodhue and Thompson, 1995). This example showcases that failure to consider TTF components in bot design and implementation can lead to inefficient use of financial and human resources, and poor bot performance.

Our interviews also revealed that accountants' roles in the organizations are changing as are the skills required. As a result of bots' ability to perform tasks that were previously performed by human employees, there seems to be a lot of uncertainty regarding the roles that human employees would play while working alongside the bots. There is a definite opportunity for accountants to expand their skills relating to business processes and improvement, exception analysis, and robotic software development, testing and support. Future research could explore the ways in which automation is changing the work of accountants, the unique roles that accounting and finance professionals are playing in digital transformation of their organizations, and the skills and competencies that accountants should develop in order to work alongside their digital colleagues. As RPA implementation matures, future research could examine the long-term effects of RPA and related technology implementation on organizations and its employees, their job satisfaction and retention. The focus of this study was on task analysis related to the order-to-cash, procure-to-pay and record-to-report cycles. Other areas that could be considered for further exploration include the impact of RPA on the hire-to-retire area, the internal tax function and the internal audit role, particularly the evaluation of internal controls within the RPA environment. Future research could also examine how organizations transition from unintelligent automation with RPA to sophisticated cognitive technologies, artificial intelligence for accounting and finance work.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.accinf.2019.100431.

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