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Identifying Characteristics for Success of Robotic Process Automations

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IDENTIFYING CHARACTERISTICS FOR SUCCESS OF ROBOTIC PROCESS AUTOMATIONS

THESIS

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Abstract

Air force talent should be cultivated and used on tasks that appropriately utilize that talent. In the pursuit of digital transformation, the Air Force creates digital airmen. Digital airmen are robotic process automations designed to eliminate the repetitive high-volume low-cognitive tasks that absorb so much of our Airmen's time. The automation product results in more time to focus on tasks that machines cannot sufficiently perform—data analytics and improving the Air Force's informed decision-making. Currently, the Air Force uses UiPath and Blue Prism to streamline user interaction with its legacy systems. This research investigates the assessment of potential automation cases to ensure that we choose viable tasks for automation and that the automations have the best opportunity for success. This research applies the multivariate analysis of researched characteristics of Air Force processes to determine which factors significantly indicate successful projects. The data is insufficient to provide significant insights.

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IDENTIFYING CHARACTERISTICS FOR SUCCESS OF ROBOTIC PROCESS AUTOMATIONS

I. Introduction

A citizen developer is a user who creates new business applications for consumption by identifying opportunities to implement low/no code development and runtime environments that do not require programming skills. In the past, end-user application development was typically limited to single-user or workgroup solutions built with Microsoft Excel and Access tools. However, today, citizen developers can build departmental, enterprise, and even public robotic process automations (RPAs) using low-code development platforms such as UiPath. RPA bots developed by airmen perform repetitive, structured processes to promote process improvement and effective use of airman talents and time.

Problem Statement

This research analyzes the features of the Air Force's automation efforts to help identify the most viable candidates for successful automation.

Background

A chief contributor to the lack of data capability is the technical debt accumulated from legacy systems within the Air Force (Nystorm, 2021). Technical debt is "technical shortcuts made to meet delivery guidelines" (Atlassian, 2020). The Air Force is still affected by previous software delivery methodologies that often did not meet their intended use and legacy systems that require manual data entry and other menial tasks that can be automated. Robotic process automation is helping to minimize this technical debt while we continue to improve our processes. Performing RPA more effectively and efficiently will improve how we mitigate this technical debt. This research identifies characteristics of automation candidates to improve the selection of tasks that are automated which will aid in the improvement of Air Force processes more rapidly.

The Air Force has turned to digitalization and automation to focus resources on mitigating this technical debt. The dominating robotic process automation in the military is UiPath. It reduces the time spent on repetitive, high-volume, rule-based tasks. This improvement frees up airmen to utilize their talents for process improvement and limit technical debt. The UiPath automation campaign has effectively increased its user base and deployed hundreds of automations across the Air Force. Automating tasks improves process efficiency by looking into prosperous and retired automation factors to understand why the process has changed.

The original intention of this research was to outline a process and apply data automation to develop a culture of continuous improvement and data capability via agile practices and no/low coding application development platforms of enlisted airmen. The turning point occurred when we found the UiPath campaign, which outlined a process for training airmen on robotic process automation, is being implemented Air Force-wide. Hence, this research focuses on identifying the characteristics of automated tasks to determine what impacts automation success.

This research follows the principles of the DOD data strategy and aids in developing the essential capabilities of improving our data architecture, talent, and culture (Norquist, 2020).

> **Guiding Principles**
> DoD must implement IT solutions that provide an opportunity to fully automate the information management lifecycle, properly secure data, and maintain end-to-end

records management. Also, "As such, DoD is making the cultural shift from the need to know (i.e., information withholding) to the responsibility to provide (i.e., information sharing)."

Essential capabilities
Talent and Culture – DoD workforce (Service Members, Civilians, and Contractors at every echelon) will be increasingly empowered to work with data, make data-informed decisions, create evidence-based policies, and implement effectual processes.

Architecture
DoD architecture, enabled by enterprise cloud and other technologies, must allow pivoting on data more rapidly than adversaries can adapt. (Norquist, 2020)

This research aids in prioritizing potential automation processes by identifying what characteristics most impact the success of an automation. This research shows what characteristics are correlated with successful automation implementation. With this improvement to the selection RPA, Airmen can automate tasks more successfully. Doing this will allow them to better allocate their time to focus on analytical methods, provide quality results, and concentrate on the work that makes them productive at their mission. We meet the essential capabilities of the DoD data strategy through the data-driven insights that could enhance the training for citizen developers and RPA developers. We work to aid the effective implementation of RPA tools and enable Airmen to automate their workflows as efficiently as possible.

II. Literature Review

We examine the literature of characteristics for viable automation projects to compare automatable tasks through a questionnaire that evaluates the task based on critical values found in RPA literature. This literature review involves six sections. We start with describing citizen developer since our goal is to enhance airmen developers. Subsequently, we explore the literature on viable automation projects and exploring robotic process automation (RPA). We examine two RPA software, UiPath and Blue Prism. The final two sections address traditional process automation along with standard automation tools.

A. Citizen Developer

A citizen developer is a creative problem solver who develops applications and solutions using low code tools sanctioned by their organizations. They usually have little to no programming experience or experience with application development. This lack of software experience does not stop them from recognizing a problem and creating corresponding solutions. An organization that recognizes its citizen developer population as a resource can employ agile software solutions with higher completion rates than general software development solutions. Citizen developers are encouraged in today's Air Force via professional development courses. Lessons on how to be a citizen developer are being taught in tandem with automation roadshows. (Nystorm, 2021)

Courses and low-code development resources are available to create not only automations but also web applications. The 402nd Software Maintenance Group of Robbins AFB has recognized the need to empower its citizen developers by adopting a low-code platform that its users can leverage to develop web-based applications in a secure environment. The platform Appian is the base of their agile software factory. The unit continuously develops and deploys its applications such as commander's dashboards, hazard reporting tools, talent management, and many more applications.

The USAF Contracting-Information Technology program also adopted Appian. The mission system is hosted in impact level 4 cloud and has replaced seven legacy contract writing systems. This adoption has resulted in initial cost avoidance of at least $80 million and a consolidated system that managed to spend $10.5 billion in 2019 alone. (Appian, 2020) These are premier examples of the digital transformation that can be fast-tracked to success by saving time and money by eliminating manual work performed on high volume automatable tasks.

B. Viable Automation Projects

The groundwork for assessing automation task’s suitability starts with Figure 1. Given general definitions of the type of automated processes, the user can evaluate their approach and provide an evaluation. Prospective users are inclined to align their task with the trendy topic of robotic process automation, so there are concerns of subjectivity in the assessment once people outline the process.

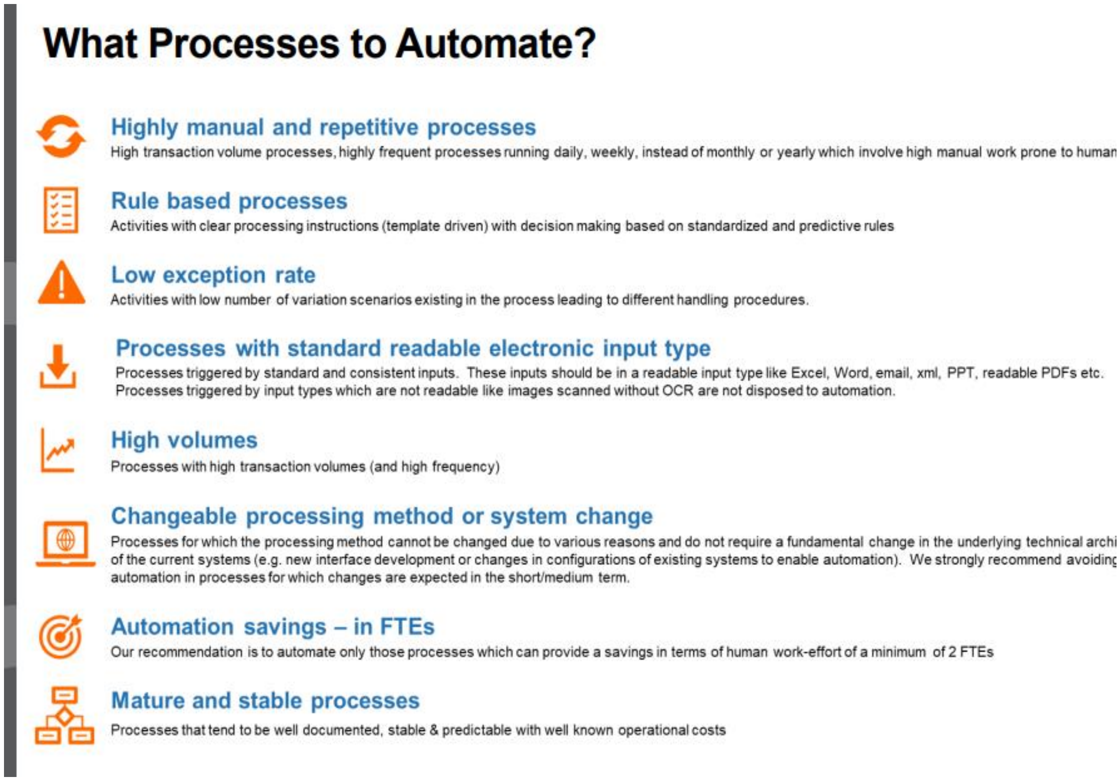

Figure 1 General criteria for automation currently being used within the UiPath campaign in the Air Force (Nystorm, 2021)

The primary objective of this literature review is to find what industry has done to evaluate their potential automation cases and to identify the most common themes in characteristics in RPA literature. Industry's experience enables the empirical evaluation of characteristics to identify what contributes most to successful automation.

Wellman, Stierle, Dunzer, & Matzner (2020) identify the following criteria as essential for automation:

- A process or task should be thoroughly defined and structured.
- A process or task should have limited process variations.
- A process or task should be highly standardized.

Acceptable circumstances of deviations from the previously stated criteria exist and are on a case-by-case basis on the implementation of RPA. The rate of deviations is tracked and denoted as the failure rate. Business analysts must assess appropriate levels of failure to identify if the automation can perform the tasks and create failures as a byproduct at an acceptable level. All decision-making by the software needs to follow a rule-based flow. Objective decision-making is the only capability present. If the process requires subjective judgment or interpretation the RPA will not appropriately perform the task. The most attractive tasks for automation are often monotonous tasks with a low cognitive requirement. Eligibility for automation aside, the frequency of a task is performed helps determine the business value for automating that task. Wellman, Stierle, Dunzer, & Matzner (2020) developed a list of automation features using an exhaustive search in Google Scholar, Scopus, and IEEE Xplore Digital library shown in **Table 1.** This concept matrix tracks the occurrence of each criterion within RPA literature.

Table 1 Concept Matrix showing Systematic mapping results (Wellman, Stierle, Dunzer, & Matzner, 2020)

	Standardization	Frequency	Number of Systems	Structuredness of data	Maturity	Proneness to human error	Failure rate	stability	Value	Handover of work	Execution time
(Fung, 2014)		•	•				•	•	•		
(Anagnoste, 2017)	•		•								
(Fernandez & Aman, 2018)	•	•	•			•					
(Leshob, Bourgouin, & Renard, 2018)	•	•			•						
(Moffitt, Rozario, & Vasarhelyi, 2018)	•	•		•	•						
(Penttinen, Kasslin, & Asatiani, 2018)	•	•	•					•	•		
(Beetz & Riedl, 2019)	•			•	•		•				
(Cooper, Holderness Jr, Sorensen, & Wood, 2019)	•	•	•	•							
(Hofmann, Samp, & Urbach, 2019)	•	•	•								
(Huang & Vasarhelyi, 2019)	•	•	•	•	•						
(Ivancic, Vugec, & Vuksic, 2019)	•	•	•			•					
(Jimenez-Ramirez, H.A., Barba, & Del Valle, 2019)	•	•	•			•	•				
(Kokina & Blanchette, 2019)	•	•	•	•						•	
(Osmundsen, Iden, & Bygstad, 2019)	•	•	•	•							
(Santos, 2020)	•	•	•	•	•	•		•			
(Sonmez & Borekci, 2019)	•	•	•								
(Wanner, et al., 2019)	•	•	•	•	•	•	•	•		•	•
(Yatskiv, et al., 2019)	•	•	•			•			•		
(Zhang, 2019)	•		•								
(Hindel, Cabrera Prez, & Stierle, 2020)	•	•			•	•					
(Syed, et al., 2020)	•	•	•	•	•		•				
Total	20	18	17	9	8	7	5	4	3	2	1

Capgemini Consulting (2016) provides the following data automation characteristics: Low cognitive requirements, frequent, high volume, significant peaks in workload, high probability of human error, limited exception handling, and limited human intervention are typical criteria for suitable automation tasks. Their criteria can have a range of acceptable values.

Fung (2014) states the best candidates for automation meet the following criteria: minimal knowledge required, high-frequency, query different systems and applications, standardized, low level of exceptions to the process, and significant chance of human error.

System measures on data handling and error handling are also criteria for automation. Tracking the flow of data is another case for automation potential. Cases that involve the processing or transfer of data between systems are high-value cases for automation. (Yatskiv, et al., 2019) Generally, the exceptions to completing a process should be limited if not zero. Low to no exceptions limit or prevent human interaction in the system. Tasks with unavoidable exception handling cannot be fully automated, but this does not mean the process could not benefit from partial automation. Full automation is the absence of human interaction except for quality assurance.

Assembling these criteria into more broad themes, Wellman, Stierle, Dunzer, & Matzner (2020) demonstrate the state of RPA literature by documenting the occurrences of these themes in literature. These themes of RPA literature are accounted for and systematically mapped onto a concept matrix shown below. From left to right, the concept matrix exhibits the prevalence of these themes.

Most experts agree on certain criteria, while others see value in tasks that don’t necessarily meet those criteria. For example, maturity is a common theme in literature, and it typically refers to a process remaining mostly unchanged for a year or more after automation. Other indicators of maturity include if a task has been unchanged for the past two years and there are no foreseeable changes to the process. A task set to change in the next six months would not be mature. However, the benefits of reallocating resources from automating the task may be necessary or highly beneficial in terms of cost and time savings. Circumstances in the DoD may provide a reason to keep an old system around. The decision to implement automation may factor in probable delays related to the replacement of a process. If a six-month deadline is likely to shift further, the case for automation becomes stronger. Maturity is an aspect of automation that does not directly impact the development of the automation, but it does impact whether the automation will fulfill its intended purpose. Should the process change, the effort spent on automation cannot be recouped over time, nor can it continue to accrue time savings (Syed, et al., 2020).

A highly cited paper on automation criteria by Beetz & Riedl (2019) defines a list of criterion for automation and establishes a preferred rating for automatable tasks (as shown in

). These criteria helped formulate the questions used to obtain the data in this research. The ratings serve as a frame of reference when analyzing the data acquired in this research.

Table 2 Criterion for automation (Beetz & Riedl, 2019)

Criterion	Definition	Preferred Rating
Degree to which the process is rule-based	Criterion gives an indication if a business process follows a logical flow with if-then decisions that have clear and unambiguous rules (Fersht and Slaby 2012; Sutherland 2013; Willcocks et al. 2015b).	High: complete rule-basedness with clear if-then decisions
Degree of human intervention	Criterion concerns the extent of human interruptions in a business process, which are necessary because cognitive judgement, interpretation skills or verbal communication are required (Asatiani and Penttinen 2016; Kroll et al. 2016; Lamberton et al. 2017).	Very low: no cognitive judgement at all is required
Structuredness of data	Criterion indicates whether the data that is processed is available in a structured format (i.e. as tables, relations or with a defined pattern) (Hegde et al. 2017; Lacity and Willcocks 2016b).	High: all data is available in a structured format
Degree of process digitization	Criterion refers to the extent to which electronic processing of a business process is enabled so that it can be executed by the RPA software (Alberth and Mattern 2017; Gißmann 2017).	High: complete end-to-end processing via electronic IT systems
Degree of similarity of environments	Criterion relates to the similarity between the development, test and current production environment (Hegde et al. 2017).	High: complete congruence of all environments
Labor intensity	Criterion relates to the product of the volume of a business process over a certain time period and the amount of time it takes to execute the process, based on which the FTE can be determined (Fung 2014; Kasslin 2017; Stople et al. 2017).	High: at least three FTE are involved in the manual processing
Number of systems involved	Criterion indicates how many system applications need to be accessed or are involved during the execution of a business process (Kirk 2017; Kroll et al. 2016; Willcocks and Lacity 2016).	Very low: not more than one system application is involved
Degree of process maturity	Criterion indicates the frequency of changes related to the execution procedure of a business process or rule (Willcocks et al. 2017).	High: no changes for at least two years are expected
Knowledge about current process cost	Criterion concerns the enterprise's clear understanding of the current cost that is associated with the manual delivery of a process (Asatiani and Penttinen 2016; Seasongood 2016).	High: availability of up to date documentation regarding time, staff and resources
Number of (known) exceptions	Criterion provides information about the number of exceptional process flows that deviate from the common process flow (Dunlap and Lacity 2017; Fersht and Slaby 2012; Fung 2014).	Very low: at least 90 percent of cases follow the common flow
Frequency of system related changes	Criterion concerns the frequency of changes in the user interface of process-related system applications (Asatiani and Penttinen 2016; Kasslin 2017; Willcocks et al. 2015c).	Very low: no significant changes for at least two years are expected
Number of process steps	Criterion indicates the amount of individual work steps within the execution of a business process (Lacity and Willcocks 2015).	Very low: no more than 15 individual work steps
Risk-proneness	Criterion concerns the susceptibility to operational risk of an automation, which has not been developed correctly, which is not prepared for changing situations or which is strongly dependent on the general platform stability (Fung 2014; Seasongood 2016).	Very low: no foreseeable risk to people, reputation or finances, as process is fault-tolerant
Process standardization	Criterion determines the standardization of a business process, which translates to a uniform processing within an enterprise amongst various stakeholders (Asatiani and Penttinen 2016; Kasslin 2017).	High: uniform processing is achieved by extensive documentation and knowledge transfer

Building on Beetz and Reidl (2019), Wellman, Stierle, Dunzer, & Matzner (2020) develop an exemplary framework for evaluating potential automation projects shown in Table 3. Their framework accounts for five perspectives: task, time, data, system, and human. The task perspective measures if the project fits the typical structure of automation. The authors evaluate a task perspective by evaluating standardization, maturity, determinism, and failure rate. The combination of these criteria judges the automation potential. Automation potential is the prerequisite for determining if a task is suited for RPA development. The other perspectives assess the business value and success of the automation. The time and human perspective measure an activity's scalability and business value by looking at duration, volume, and the number of resources. Data and system perspectives address the complications that arise during automation. Lack of structure and communication between multiple systems often have a significant negative impact on development time and the risk of automation failure.

Table 3 Exemplary evaluations for criteria (Wellman, Stierle, Dunzer, & Matzner, 2020)

Perspective	Criteria	Exemplary Evaluation
Task	Standardization	Number of different activities Number of variations to execution flow in business
	Maturity	Number of deviation cases over time Ratio of deviation cases over time
		Number of deviation cases over time Ratio of deviation cases over time
	Determinism	Number of manual interactions Time to solve manual interaction
	Failure rate	Number of unsuccessful terminations Number of manual interactions Number of rework loops
Time	Frequency	Number of executions
	Duration	Average time to task completion
	Urgency	Average reaction time
Data	Structuredness	Consistent use of data objects
System	Interfaces	Number of execution steps Time spent on application interface
	Stability	Number of exceptions
	Number of systems	Number of systems involved (e.g. CRM, ERP)
Human	Resources	Number of users performing same task Number of users involved in process
	Proneness to human error	Number of exceptions Time to solve exception

With this summary of characteristics of task to automate, we investigate automation approaches.

C. What is RPA?

Robotic Process Automation (RPA) is the development of software robots to perform human tasks. To complete structured, high volume, and repetitive tasks, these robots are developed to extend the availability of human workers to perform tasks that are less structured and require human thinking. Enriquez (2020) eloquently poses RPA creations as “the technological extrapolation of a human worker." Robotic process automation is a means to replace human workers by developing robots to reduce manning.

RPA is typically an easy addition to a company’s network. The Institute for Robotic Process Automation and Artificial Intelligence (2019) states that RPA sits on top of the infrastructure of the IT systems and hence is not intrusive. For example, hosting software on the Air Force network is a significant security concern; since RPA does not require changes to the legacy system's infrastructure, UiPath is an approved software for use on the network.

The decision to implement RPA depends on whether the cost to implement is less than the worker's cost and the expected lifecycle of the process. This business evaluation decision must account for the price of a license and how well the robot will work. Capgemini Consulting (2016) estimates license costs to be 20-33% the cost of a full-time employee (FTE), and depending on the software and the task, the robot can perform the equivalent work of two or five FTEs. In “A new approach to automating services," Willcocks & Lacity (2016) describe the following advantages:

- RPA is easy to configure, so developers do not need programming skills.
- The RPA software is not invasive; it rides on existing systems without creating, replacing, or developing expensive platforms.
- RPA is secure for the company. RPA is a robust platform designed to meet the IT requirements of the company in terms of security, scalability, auditability, and change management.

The Air Force's evaluations are different considering the acquisition cost of the RPA licenses. The licenses were roughly 90% discounted with a volume of 10,000. This discount made UiPath an attractive platform. The affordable cost meant there was a low financial barrier to implementing RPA technology. The primary concerns for the Air Force are maximizing success in terms of airman talent development, man-hour saving, cost reduction, production improvement, and process improvement. While the advantages of using RPA are many, citizen developers should not abandon caution with the implementation of RPA. Some tasks are more automatable than others, and some have a higher value.

J. G. Enríquez (2020) defines 48 functionalities to the automation process and identifies the gap in the analysis phase of most RPA tools. The systematic mapping documents the process and roles involved in automation. Three parties are involved (Subject Matter Experts – SME –, Business Analysts – BA –, Citizen Developer – CD –). The BA work with the SME to document the process and the steps required to complete it. The BA gathers all information such as the clicks, rules, logic, and data entry. The BA then works with the CD to test and plan for the release of the RPA tool. The tool and process should monitor the bots to affirm their effectiveness and manage change. The development cycle is below.

• Analysis Phase. This phase consists of analyzing and determining the viability of carrying out the automation of a certain process by means of a detailed analysis of the effort involved in the self-motivation of such process considering the execution characteristics of the process itself.

• Design Phase. The process design phase begins for those processes that have passed the previous feasibility analysis. The purpose of this phase is to detail the set of actions, data flow, activities, etc., that must be implemented in the RPA process.

• Construction Phase. This phase consists of implementing each of the automatable parts of each process identified in the design phase.

• Deployment Phase. The robots obtained as a result of the construction phase need an environment in which to be executed, just as a human operator needs an environment in which to perform his work. This environment, in the context of RPA, usually corresponds to a computer that has an installation of one or more information systems. Each robot must be executed in its own execution environment since the replacement between human operator and software is direct.

• Control and Monitoring Phase. Once the robots are deployed in their respective execution environments, this phase oversees controlling and monitoring the performance of each robot. In this phase, the execution of robots is launched, it stops in case of serious errors, the execution status is monitored, etc., until they have finished their work.

• Evaluation and Performance Phase. The last phase of the process consists of the evaluation of the robots' performance (J. G. Enríquez, 2020).

The Air Force and DoD are primary two RPA tools: UiPath and Blue Prism so we summarize those efforts.

D. UiPath Campaign Within the Air Force

The UiPath campaign gains spotlight with the digital wingman challenge and with testimonials from high-ranking officers. Figure shows an evaluation of automation platforms by plotting capability offering (features) to marketing strategy (targeted audiences, key partnerships, etc.) (Le Clair, 2017). Analysis of market strategy and capability offering of automation platforms places UiPath at the lead, followed by Automation Anywhere, and Blue Prism (a software for a limited population in the DoD). UiPath's superiority and steep discount price are among the main reasons for adopting this platform throughout the DoD.

Figure 2 Le Clair (2017) identified UiPath as the market leader.

The RPA effort is DoD-wide, and UiPath accounts for more than 90% of automations in the DoD (Nystorm, 2021). UiPath supports the training of citizen developers. Luke Chen (2021), an editor in the Air Force RPA community, details four steps in the automation process below.

Step 1: Understand Robotic Process Automation (RPA) and the Air Force

A great starting place would be to visit the Air Force Center of Excellence for RPA (DoD, 2021) on MilSuite to get acquainted with the RPA community. This forum will allow collaboration and sharing of RPA efforts DoD-wide. The community is an excellent source for standing-up RPA programs, debugging, and improvement issues in the Air Force.

Step 2: Install the UiPath Studio Application and Get Licenses

Install UiPath's Studio by searching for the software center via the start menu on an AFNET connected computer. Studio is the graphical user interface for users to create and utilize bots. Trial versions and free community licenses are available but are not for development in the Air Force. Acquiring a license requires form submission on the Cloud One RPA website. The user can decide whether to request a Studio (more flexibility for users with programming experience) or Studio X (structured development for users with no/low programming experience) license. More Studio X licenses are available than the Studio license because Studio licenses are for users experienced with programming. A benefit of utilizing the cloud is that it allows the license to follow the user rather than a specific system.

Step 3: Learn how to build and run bots using UiPath Studio

The curriculum for learning how to use UiPath studio has a low barrier to learning. Users do not need programming experience to participate in the starter course, which is the only requirement for a Studio X license. We recommend RPA citizen developer foundations and RPA developer foundations courses for added customization and capability for more advanced users.

Step 4: Begin to automate your workflows

The training teaches the user how to begin automating their workflows. To start, the user must break down their process into steps in a process map. This document outlines the conditions and rules and the sequence of events for the process. This document can aid a developer in understanding and aiding in the process even if they are unfamiliar with the topic. The process map is an aspect of the process definition document used to track official RPA implementations. The process definition document details project-specific requirements and helps the user identify if their project meets essential automation criteria.

The Digital Wingman Challenge

The Digital Wingman Challenge documents its best entries and winners at robot4everyairman.net. Through this challenge, aspiring RPA developers can find mentorship and recognition for their work. As of September 2021, the competition enters its fourth wave and continues to spread the ideas of automation Air Force-wide. This challenge has been effective at spreading the use of RPA platforms by recognizing airman that have provided the Air Force significant time savings with their automations.

Identifying the Most Successful UiPath Automations

The goal of the UiPath movement seems to be commercially oriented. Their goal seems to be: spread UiPath and automation to every corner of the DoD. This goal may artificially increase users of the software but does not ensure the software is used effectively and that the Air Force is getting the most benefit from automation. Since the automation opportunities far outnumber the RPA developers, guidance and priority for identifying potentially successful automation opportunities may be beneficial to the movement. Currently, the advertising points for what processes to automate are shown in Figure 1. We can expand upon these characteristics to determine what will make automation most successful, and some of the criteria are in the multi-criteria evaluation model. (Beetz & Riedl, 2019)

E. Blue Prism Use Within DoD

A software alternative to UiPath is Blue Prism. Primary uses of Blue Prism are due to existing staff having experience using the software. Within the DoD RPA Consortium, Sterrett (2021), with the Army's Logistic Data Analysis Center, is the only one using Blue Prism continuously. A choice feature of Blue Prism is that the process definition document uploads into Blue Prism, which allows for quicker automation. Blue Prism also offers a process assessment tool to help assess the business value of potential automation candidates. Much like UiPath, there are many similar friction points. Some of those are cybersecurity issues with unattended automation, lack of standardization of systems involved, and lack of rules and procedural guidance. Combining the learning communities of UiPath and Blue Prism would enhance capabilities that would support the goal of this research and the goals of the organizations. The independent workflows of this automation software allow for better solutions when users share their automations at RPA consortiums.

Having completed this summary of two predominate RPA tools in DoD, we examine related software development tools and process.

F. Traditional Process Automation vs. Robotic Process Automation vs. Business Process Management

There are many ways to improve a process. This section focuses on identifying which method is most appropriate for a process. Sibalija, Jovanović, & Đurić (2019) describe robotic process automation (RPA) as a software solution designed to perform humans' repetitive procedures or tasks. Typical RPA tasks are opening applications, autoreply to emails, and copy and pasting from system to system. Slaby (2012) introduces the concept of traditional process automation (TPA) and compares it to robotic process automation. The concept of TPA is the business analyst's tool of streamlining processes to remove inefficiencies in a system. RPA differs in that its practical use increases work efficiency by automating repetitive tasks. Incorrect use of RPA leads to the early retirement of RPA bots because of the need for process improvement. The motive behind using RPA on systems that could use a TPA transformation is that it requires minimal effort compared to transforming the information system. Tactically implementing RPA mitigates the hours needed to maintain the operability of the current system, which will allow for more hours for traditional process improvement. Another reason we may not use TPA because the organization is in no position to eliminate the legacy system or handle the complexities of a system transformation. RPA can operate on top of existing applications much like human interfacing with applications and does not require much effort. (Slaby, 2012)

Table 4 Contrast of BPM and RPA (Santos, 2020)

Domain	BPM	RPA
Business goal	Process reengineering (Forrester, 2014; Lacity et al., 2016)	Automation of existing processes (Lacity et al., 2016)
Application	Creation of a new application (Forrester, 2014; Khramov, 2018; Lacity et al., 2016; Lacity and Willcocks, 2015)	Use of existing applications (Aguirre and Rodriguez, 2017; Lacity et al., 2016)
Integration Method	Interacts with business logic and data access layers (Khramov, 2018; Lacity et al., 2016; Lacity and Willcocks, 2015)	Interacts with systems through the presentation layer (Aguirre and Rodriguez, 2017; Lacity et al., 2016; Lacity and Willcocks, 2015)
Process Suitability	Best suited for processes requiring IT expertise on high-valued IT investments (Suri et al., 2017)	Suitable for processes that require business and process expertise (Lacity et al., 2016; Suri et al., 2017)
Programming Requirements	Requires programming skills (Cewe et al., 2017; Khramov, 2018; Lacity and Willcocks, 2015)	Does not require programming skills (Aguirre and Rodriguez, 2017; Khramov, 2018; Lacity et al., 2016)
Development Responsibility	Development by programmers (Lacity et al., 2016; Suri et al., 2017)	Development by the business unit (Lacity et al., 2016)
Development Times	Long development times (Mindfields, 2015)	Fast development times – no complex integration required (Mindfields, 2015)

A comparison of business process management (BPM) and RPA are shown in Table 4. BPM is the re-engineering of a process. It is like TPA in terms of making a process more efficient, but different in how the process and the business model can sometimes be completely reworked to better meet an organization's goals. BPM requires a business analyst and developer with programming experience to optimize the process to better mesh with an organization’s information systems. Any method that undergoes

BPM is a prime candidate for RPA. Conversely, any process that undergoes RPA may have to be re-engineered, which will cause the RPA to be retired and renewed.

G. Additional Methods of Analysis for Improvements

We review several traditional software development tools that may aid in RPA construction. Specifically, we summarize data flow diagrams, entity-relationship diagrams, agile methodology, process mining, and automation in the cloud.

a. Data Flow Diagrams

The more a system stores, processes, and retrieves data, the more we can see the benefits of automation. Understanding that a task with these operations possesses a key characteristic of a viable automation candidate, tracking the data flow can measure that characteristic. A developer can use a data flow diagram instead of process maps if they already exist. *Modern Systems Analysis and Design* defines data flow diagrams (DFDs) and their use in information systems.

> DFDs are used to study and document a system's processes. First, a context diagram shows the scope of the system, indicating which elements are inside and which are outside the system. Second, DFDs of the system specifies which processes move and transform data, accepting inputs and producing outputs. These diagrams are developed with sufficient detail to understand the current system and eventually determine how to convert it into its replacement. This logical progression of deliverables enables us to understand the existing system. You can then abstract this system into its essential elements to show how the new system should meet the information-processing requirements identified during requirements determination. (Valacich & George, 2017)

b. Entity-Relationship Diagrams

Existing systems have used entity-relationship diagrams to map out how the system's entities interact. These detailed diagrams can be used instead of the process definition document for the evaluation of the process for BPM, TPA, or RPA.

> An entity-relationship data model (E-R model) is a detailed, logical representation of the data for an organization or for a business area. The E-R model is expressed in terms of entities in the business environment, the relationships or associations among those entities, and the attributes or properties of both the entities and their relationships. An E-R model is normally expressed as an entity-relationship diagram (E-R diagram), which is a graphical representation of an E-R model. (Valacich & George, 2017)

c. Agile Methodology

The agile principles below seem self-evident, but the effective application of agile methodologies is difficult. These principles are based on the Agile Manifesto written by the group who calls themselves "The Agile Alliance". (Beck, 2001)

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on becoming more effective, then tunes and adjusts its behavior accordingly.

The emphasized values are "individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change following a plan". (Scrum Alliance, 2021) According to a study conducted at Metropolitan State University on students in the Management Information Systems undergraduate degree program, students found that their comfort and familiarity with agile methodologies increased with the use of Microsoft PowerApps (a no/low code development platform) for their assignments instead of traditional coding platforms. (Leben & Finnegan, 2021) This opportunity to shift the limited focus of the individual on the intensive aspects of coding allows for the development of a systems improvement mindset sought after by employers. The expected return on the investment in agile methodologies in software development is a product that meets the intended objectives and that provides the most value to an organization.

d. Process Mining

Process mining provides insights into maturity and helps identify the largest automation activities. Data extracted from SAP (System Applications and Products in Data Processing) database tables provide information on the activity, timestamp, and the type of user performing the process activities. This data enables the calculation of automation rate, which is the number of automations (system users) divided by the total number of cases. Understanding the flow of data can help identify the best opportunities to automate. Standardization of business processes through process improvement is a prerequisite to automation. The potential use cases often surpass the resources available to automate, so there must be a priority of tasks to automate. This paper finds that there are generally faster benefits for low automation rates for processes. Process mining also aids in the continuous performance monitoring of the processes. (Geyer-Klingeberg, Nakladal, & Baldauf, 2018)

e. Automation in the Cloud

UiPath Orchestrate (platform for managing and sharing automations) is on track for being on Cloud One. The platform would enable users to manage and share automations from anywhere that can connect to Cloud One. Cloud One is a cloud hosting service that utilizes Amazon Web Services and Microsoft Azure (Cloud One, 2021). Automation in the cloud allows for increased flexibility when accessing automation and automatic scaling to match the demand for automations. Implementing automations successfully relies heavily on an organization’s adoption of cloud service capabilities (Braley, 2021). Lack of adoption of cloud services “has led to Departmental inefficiencies and has hindered the Department in IT modernization efforts (Department of Defense, 2018). This lack of adoption is due to isolated teams, siloed data, inefficient acquisitions, and weak implementations with limited capabilities that have complicated the digital modernization sought after in today's Air Force.

When government security requirements and commercial cloud policies fail to align, agencies must resort to on-premises services or a mix of the two. Security and wasted resources are why automation may not be appropriate for these agencies in transition. There are security concerns with unattended automation running between these services; therefore, they have not been implemented. This restriction in security on the

Air Force network may interrupt the deployment of the automation. The DoD Cloud strategy identifies that "by owning and operating the physical hardware associated with on-premises data centers, the Department can incur unnecessary security risks and consume resources that could otherwise be realigned to support warfighters" (Department of Defense, 2018). Considering the momentum of cloud-based services in the Air Force, automating certain on-premise services may be a poor investment. The increased focus on cloud environments would force the automations created for legacy systems into retirement.

III. Methodology

This chapter has three parts that detail the reason for research focus, the data call feature selection, and the acquisition of the data. These sections explain how we chose this area of research, how we selected questions to reflect characteristics identified in literature, and the populations that make composed our data.

A. Reason for Research Focus

When this research was in its infancy, the goal was to develop a process for identifying and automating tasks and then apply this to local applications and improve the process based on the resulting automation. In learning the current state of automation, we sought contacts familiar with automation. Our first contact was with the Air Force Academy's Data Science and Operations Research faculty. This conversation introduced us to the idea of the citizen developer, some suggestions for mapping processes, and Microsoft Power Automate. We considered the suggestions, but we centered the research around the idea of citizen developers. Initially, we focused on the low-code development of end-user applications such as a commander's dashboard that provides business intelligence in real-time to the decision maker.

With this end goal in mind, we laid out the framework for getting a non-technical person educated in critical concepts and techniques to automate a task associated with their work. We sent out a call for projects across Wright-Patterson AFB to identify potential projects. The result was contacts and suggestions for applications, however, we also learned of the Air Force acquiring 10,000 UiPath licenses and associated Air Force-sponsored Digital Wingman challenge. We contacted this group to get input on the process we created, only to find that they had similar goals and, more importantly, they had a growing interest. We decided to build on the process that they had created. We were made aware of their lessons learned on effective use of automation. They cautioned us on using robotic process automation where process improvement is appropriate.

This information led us to a question. How do we ensure the effective use of automation? It starts with the identification of the task. What aspects of a potential automation project make it more favorable than others? There are the basic requirements associated with the definition of robotic process automation. The task must be manual, repetitive, and high volume. The UiPath group further defined tasks to automate by defining rule-based processes, low exception rate, standardized electronic input type, mature, and stable. The group focused on other aspects of automation: time savings equal to at least two full-time employees or cannot change for various reasons. **Figure** shows how to evaluate an automation task according to the previously listed process characteristics.

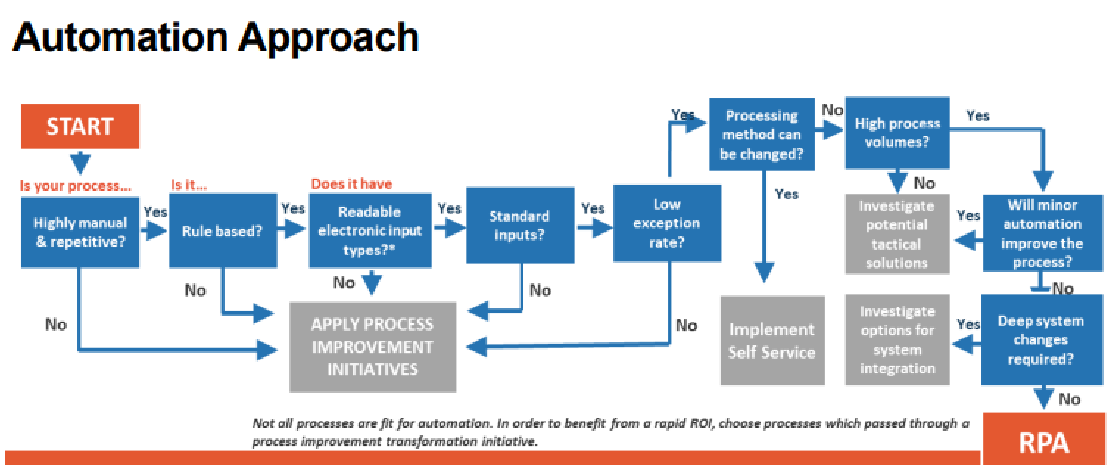

Figure 3 Automation approach for UiPath (Nystorm, 2021)

We know of no data indicating tasks with the features in Figure are necessarily worse for automation. Nor is there much detail given to qualifying tasks as appropriate for automation. The goal of this research became gathering data on application characteristics that would accurately predict the success of an automatable task. The analysis of this data uses regression techniques to determine what characteristics contribute most to success. The following questions help to examine how tasks measure up to characteristics derived from Beetz & Riedl (2019), Wellman, Stierle, Dunzer, & Matzner (2020), Santos (2020), and process improvement forms from SAF/MG. The next section describes our resulting data call.

B. Data Call Feature Selection

The questions in the data call were selected to reflect characteristics found in RPA literature. Our questions contain basic information (name and status), task information (measures associated with savings/ business value), and automation aspects (characteristics that may make a task more suited for automation). **Table 5** shows the question and corresponding justification in our data call.

Table 5 Data Call Questions and Rationale

Question (Variable Name)	Statement of significance
Basic Information	
1. What is the automation's name? (Name)	The automation's name helps to align previously collected data and serves as an identifier for all

	attributes associated with the process
2. Automation status <u>(Status - categorical)</u>	This characteristic helps to identify the stage of development the automation is in. Options are Deployed, retired, and still being assessed for use. Processes classified as deployed are expected to be quality data points. Whereas automations being assessed for use (while still useful data) are mostly estimates.
Task Information	
3. How many different activities on the process map are manual? <u>(# of different activities)</u>	This question refers to the sequence of steps needed to perform a task. Steps are defined as clicks, data entry etc. The total number of activities accounted for will be used as a proportion so that all data entries are comparable.
4. How many termination points does the process have? <u>(Termination points)</u>	This question refers to the branches a process might have. The process may have conditions that cause a decision to be made. The task may have to be completed differently dependent on certain criteria.
5. How many times is this process performed at your unit per year? <u>(Frequency)</u>	High volume tasks are prime candidates for automation because the frequency at which a task is performed is a function of savings when automated.
6. Prior to automation, what percentage of the task was strictly manual? <u>(Manual percent change = prior - after)</u>	Robotic process automation mimics manual actions of the user. It is expected that process

	that are mostly manual are good candidates for automation.
7. After automation, what percentage of the task was strictly manual? <u>(Manual percent change = prior -after)</u>	Even after automation, some aspects of a process require a system user to move forward. This question aids in demonstrating the progress automation efforts have made.
8. Prior to automation, what percentage of time spent performing the task was spent waiting? (i.e. waiting for a interface to load or login credentials to validate) <u>(Percent waiting change = prior -after)</u>	This question was asked to address downtime spent waiting for a response or for an interface to load. It is expected that this percentage of time waiting can be reduced with an automation eliminating the need to track progress on the process.
9. After automation, what percentage of time spent performing the task was spent waiting? (i.e. waiting for an interface to load or login credentials to validate) <u>(Percent waiting change = prior -after)</u>	Currently users of robotic process automation tools run attended automation on their system. This means that the automation must be started by a user and there is expected residual down time between workdays.
10. Prior to automation, what was the level of process adherence? (i.e. were there skipped steps, workarounds etc.) <u>(Process adherence - categorical)</u>	Efforts of automation are often wasted when the process is the major source of inefficiency. The question will help us understand if the process required process improvement and how much it impacts the success of an automation.

11. Prior to automation, what was the average duration of the process in hours? (0.25 hours is 15 minutes) <u>(Duration change = prior - after)</u>	The duration of a process is a direct function of savings in hours when estimating the potential benefit automation can provide.
12. After automation, what was the average duration of the process in hours? (0.25 hours is 15 minutes) <u>(Duration change = prior - after)</u>	Not all automations speed up the process. Shortening the duration of a task can indicate productivity gains, but even if the duration is the same, the user is no longer actively performing the task.
Automation Aspects	
13. Would you describe the process as mature? <u>(Mature - binary)</u>	Maturity is an important perspective for automation. Task maturity implies that the process is stable enough to perform automation and recoup the efforts with added savings.
14. Prior to automation implementation, had the process been changed in the past two years? <u>(Prior to RPA changes - binary)</u>	This question is used to give a perspective on the history of the process and help assess the maturity of the process.
15. How many systems are communicating in this process? <u>(# of systems)</u>	Tasks that involve the user being the communication link between systems are associated with high error rates. Processes can be ideal for automation not only due to savings, but also due to reducing costly errors with systems.

16. Prior to automation, what percentage of process executions result in errors? <u>(Percent error change = prior -after)</u>	This question helps us to understand the proportion of user errors involved and whether automation can reduce these errors.
17. After automation, what percentage of process executions result in errors? <u>(Percent error change = prior -after)</u>	Automations are digital workers and they require supervision. Automating a task can reduce errors of one type, but can increase blatant errors that a system user would quickly recognize.
18. Average man-hours required to fix an error. <u>(Hours to fix error)</u>	Rework hours will be used in assessing the value of a process. The savings of rework can be significant enough to justify an automation.
19. Prior to automation, what was the typical delay related to starting the task? (Defined as your reaction time to start the task once the need to perform it has arisen) <u>(RPA delay change = prior - after)</u>	Some tasks have a certain level of urgency associated with them. Since the automation requires a user to initialize it, the reaction time may not change.
20. After automation, what was the typical delay related to starting the task? (Defined as your reaction time to start the task once the need to perform it has arisen) <u>(RPA delay change = prior - after)</u>	Simple unattended automations such as notification of requests can improve the response time. Improved notification of tasks can start the initialization process quicker since the work associated with the task has been reduced to mouse clicks.
21. Estimate how many man-days went into the development of this automation. Exclude initial skills training. (1 man day is 8 man-hours) <u>(Days of development)</u>	This value will be used in the calculation of savings. It is possible the creation of the automation and the initial skills training were done concurrently. Initial skills training time is

	ignored because of the inherent value in educating airmen in a useful skill.
22. How many groups with little to no modification could implement your automation? (Modest estimate) <u>(Scalability to other groups)</u>	Scalability of an automation pertains to the potential savings from replicating it. Many groups within the DoD perform the same repetitive tasks. Tasks performed by multiple groups will have significant automation potential.
23. What is the hosting environment of the process? <u>(Hosting - categorical)</u>	It is expected that process hosted on the cloud will be readily sharable with the RPA community. While not disqualifying, on premise hosting services are on a much smaller scale, and the impact of an automation may be linked to its hosting environment.
24. What development platform was used to create this automation? <u>(Software - categorical)</u>	Tracking the tools that afford developers the best capabilities can provide useful insights as to what automation platforms to recommend.
25. What was the customer impact of your automation? <u>(Customer impact - binary)</u>	Value-added from automation is not completely accounted for by hours and dollars saved. Increased response time can have a significant impact on customer relations. In contrary, in some cases of automation the automation does not account for the diversity of the needs of the customer. This can worsen customer impact.

Success Indicators (Output)	
26. Estimate annual savings in man-days. (1 man day equals 8 man-hours) <u>(Annual savings in days)</u>	Time savings is the response variable for indicating the level of success of an automation and is generally the motive behind automating processes.
27. Estimate annual savings in dollars. (Exclude your organization's labor cost) (Include labor costs if the labor was contracted) <u>(Annual savings in dollars)</u>	An equivalent response variable is monetary savings. Most tasks suitable for automation rely heavily on the manual work of a user, but in some cases there can be additional cost avoidance. This question is in place to ensure that all benefits of each automation case is accounted for.
28. What percentage did the work output increase due to automation? (0 is an acceptable answer) <u>(Output percent improvement)</u>	If the workload of a task is limited then automation frees resources to perform other tasks. Automating a task does not necessarily equate to an increase in the output if there is no additional capacity performed.
29. Overall, was this automation successful? <u>(Success - binary)</u>	We expect all responses to the form to have been from successful automation. This is due to a lack of tracking for unsuccessful automations. We believe it is necessary to confirm

	the outcome of an automation to understand the data.

Questions were reviewed and validated by our contacts in the commander's accelerated initiatives office, the process management branch at SAF/MGB, and the coordinator for UiPath and the digital wingman challenge.

C. Data Call on RPA Project Information

Contact information was collected from three groups: the DoD RPA consortium, the Air Force's Digital Wingman Challenge, and an in-person RPA roadshow training at Wright Patterson AFB. The DoD RPA consortium and Digital Wingman Challenge groups were all experienced RPA developers, while the RPA roadshow group was a combination of new users and automation developers skilled in tools besides UiPath. These populations were independent of each other. The groups had a respective population of 28, 49, and 28 and in total we received 15 entries. Hence, we had a 14 percent response rate.

IV. Analysis of Responses from the Data Call.

This section features a multivariate analysis which includes an outlier test and a correlation matrix, and a linear regression model to estimate a factor of success.

A. Multivariate Analysis

The data is composed of 15 entries with 11 continuous input variables, 6 categorical input variables, and 3 continuous output variables with one categorical output variable that indicate success. Utilizing K nearest neighbor, we determine entry 10 to be an outlier. Entry 10 has a savings more than 1,000 times larger and the nearest neighbor more than three times the average distance of the data set as shown in **Table 6**.

Table 6 Outlier test for K nearest neighbors

Largest Outliers from 8 Nearest Neighbors

Row	Distance		Near Neighbors
10	3106.698		9 3 2 15 14 8 13 4
1	1732.192		6 11 7 14 13 4 5 12
6	1000.154		14 13 5 4 15 12 2 8
3	1000.03		9 13 4 14 5 12 2 15
11	1000.029		7 14 4 13 5 12 2 15
7	1000.024		11 14 13 12 4 5 2 15
8	600.4558		14 13 4 2 12 5 15 9
9	600.2704		3 12 5 4 14 13 2 15
15	600.2704		13 14 12 2 4 5 8 9
2	600.2398		14 4 13 5 12 15 8 9
13	600.23		14 4 12 5 2 15 8 9
14	600.2238		13 4 12 5 2 15 8 9
4	600.1967		13 14 12 5 2 15 8 9
5	600.1791		12 14 13 4 2 15 8 9
12	600.1734		14 5 13 4 2 15 8 9

Therefore, in all subsequent analysis, we exclude entry 10, the number of different activities, and the response variable output savings in dollars due to insufficient responses.

Table 7 Summary of correlations between characteristics and response variables

Response Variables	Annual Savings in Days	Output Percent Improvement	Success
Task Information			
Termination points			
Frequency			0.25
Manual percent change			
Percent waiting change			
Process adherence		-0.3	0.3
Duration change			-0.58
Automation Aspects			
Prior to RPA changes	-0.27	0.6	-0.28
Mature			0.28
Number of systems	0.37		-0.39
Percent error change			0.25
Hours to fix error			-0.7
RPA delay change	0.24		-0.91
Days of Development		0.9	
Scalability to other groups			
Hosting			0.33
Software			
Customer Impact			0.68

Legend	Very (-) correlation	Moderately (-) correlation	Moderately (+) correlation	Very (+) correlation
No correlation				

Table 7 summarizes correlations with the response variables estimated with the row-wise method. All correlations can be found in **Table 8** and **Table 9** which are located in the appendix. Based on the literature, we selected these measures expecting them to be highly correlated (positively or negatively) with our response variables. The

14 observations indicate no high correlation with annual savings. Output Percent Improvement has two high correlations: however, the data is counter intuitive as longer developments on less stable systems appear to result in better output improvement. Success is a binary variable with 12 observations reported as successful and 2 reported as not successful. The widely varying results are indicative of a too small a sample size. The data from the responses at best is inconclusive and at times counter intuitive.

In the following, we examine the correlations prior to investigating regressions.

Correlation of output variables:

- ***Annual savings in days***, ***output percent improvement***, and ***success*** had no significant correlation.

Correlations of input variables to response variables:

- ***Annual savings in days*** have a low correlation with the *number of systems* (0.37), and *RPA delay change* (0.24). It also has a negative correlation with *prior to RPA changes* (-0.27).

The number of systems and eliminating delays contributes to more significant savings. The negative correlation indicates that a change in the past two years, which indicates an unstable or immature system, slightly correlates with less annual savings in days.

- ***Percent output improvement*** correlates with *days of development* (0.9), *prior to RPA changes* (0.6), and a negative correlation with increasing *process adherence* (-0.3).

Higher development time indicates more complex processes, which results in better output improvement. Higher process adherence indicates stricter policy associated with a process which may lead to a reduction in output. Percent output improvement can be unique to the task. Specific tasks have a high volume of requests that were not met with the staffing prior to automation. Due to the scalability of automations, demand of a process will be met after automation, and output will increase to equal demand.

- ***Success*** correlates with *customer impact* (0.68), *hosting environment* (0.33), *process adherence* (0.3), *maturity* (0.28), *frequency* (0.25), *percent error change* (0.25).

Customer impact may affect the adoption potential of the automation because leadership may desire to change a specific process. Hosting environment can impact the implementation of the automation; automation implemented on a cloud environment where the software has been optimized for use on the platform, chances of success may improve according to its correlation with success. Process adherence can be related to the structure of the task or rules associated with the task. Because structure is a cornerstone of RPA tasks; process adherence's correlation with success is intuitive. Maturity and percent error change impacted success positively but not as significantly as other characteristics. Frequency certainly contributes to the business value of automation and may spur the need for automation success. This data shows that frequency slightly contributes to successful automation.

- ***Success*** has a negative correlation with *prior to RPA changes* (-0.28), *number of systems* (-0.39), *duration change* (-0.58), *hours to fix the error* (-0.7), and *RPA delay change* (-0.91).

Changes made in the past two years (prior to RPA changes) are a confirmation check on maturity; this indicates that changes in the past two years equal a lack of maturity. The analysis did not detect a correlation between the maturity checks. A lack of maturity and changes in the last two years are slightly correlated with lower success potential. The number of systems indicates a significant potential for business value (output and annual savings in days). However, a possible conclusion for this negative correlation is that the complex system requirements impacted the implementation of the automations. There seems to be a trend and conflict with the characteristics typically associated with business value (duration change and RPA delay change) of automation and its success of implementation. As we increase time saved via time savings on a per-task basis, hours to fix the error, and the change in the delay to starting the task, there is an increased risk associated with the success of the automation. A new theme of future research is the ease of implementation which would serve as an adoption metric for implementing automations.

B. Linear Regression

We applied regression to identify the impact of characteristics.

$$RSquare = 0.9465, RSquare\ Adjusted = 0.9305,$$

$$\begin{aligned} Success = 1.1043 &- 0.04662(RPA\ delay\ change)(hrs) \\ &- 0.00625(Duration\ change)(hrs) \\ &- 0.08658(Changes\ in\ past\ 2\ years), \end{aligned}$$

$$where\ Changes\ in\ past\ 2\ years = \begin{cases} 0\ if\ no \\ 1\ if\ yes \end{cases}$$

Figure 4 *Success* as an output of *RPA delay change, duration change,* and *changes in past 2 years*.

Based on the 14 data points, the regression model in Figure gives a tangible way to measure a factor of success. The purpose of this model is to measure risk when automating a task, not to deter the citizen developer from choosing tasks that reduce delay or improve the duration of a task. This data indicates that the greater the value achieved from automation, the greater the difficulty with implementation. The regression model is a way of modeling success as the baseline and increasing business value as the increasing difficulty with implementation. This model could be improved if we measured success on a continuous scale.

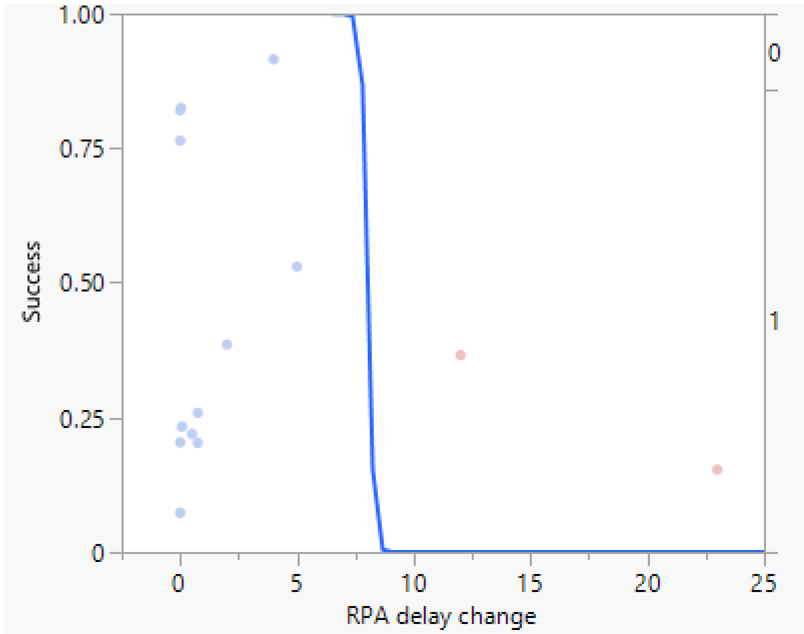

Figure 5 Logistic fit of success by RPA delay change

We utilized logistic fit to identify what characteristics clearly indicate success. Our analysis yielded only one characteristic separating successful implementation vs. difficulty with implementation. RPA delay change (response time improvement) was the only characteristic that clearly distinguished success. This data indicates that tasks with a reaction time change of more than 7 hours tend to have implementation difficulties. Possible conclusions are the level of urgency and importance of a task associated with the need for successful implementation, but this study has not measured this.

V. Conclusion

Selected tasks that meet the general criteria of structure and standardization can be automated. This analysis on the 14 data points predicts a decreasing factor of success associated with an increased improvements in task duration, RPA delay change, and immature processes (changes in the past two years). With the limits of this data mainly including successful automations, we have survivor bias towards success. We cannot assume that tasks with high-values risk failure. However, these 14 automations indicate successful automations are associated with tasks with modest time savings, a low number of systems, improved customer relations, a cloud hosting environment, a high process adherence, a mature process, a high frequency, and a high percent reduction in errors. This data does not aid in accurately predicting savings.

Future works

1. Create a screening tool to identify which projects indicate the need for process improvement and which have automation potential. Defined as a combination of screening questions and guidelines for examining a process for inefficiencies could be used to meet this goal.
2. Analysis tool that manages candidate processes, documents process characteristics, configures parameters to calculate the degree of automation (using process map), evaluate candidates based on this, provides statistics on current and expected costs/savings of candidate processes.
3. Future work may improve results by rating success on a scale.

Appendix

Table 8 Correlation matrix performed in JMP software

Multivariate

Correlations

	RPA delay change	Days of development	Scalabilty to other groups	Hosting	Software	Customer Impact	Annual savings in days	output percent improvement	Success
termination points	-0.2144	0.2542	0.4583	0.1572	-0.3221	0.1093	-0.0425	-0.0985	0.1609
Mature	-0.1574	0.1951	0.1551	0.4166	-0.3594	0.5311	0.2229	0.1350	0.2843
frequency	-0.2606	-0.0634	-0.1391	-0.2268	-0.4975	0.1605	-0.1297	-0.1971	0.2539
P to RPA changes	0.0009	0.6169	0.2093	0.2335	0.1567	-0.5684	-0.2734	0.6061	-0.2789
manual percent change	0.1886	0.3184	0.0688	-0.1663	-0.0449	-0.0464	0.0521	0.2153	-0.1786
percent waiting change	-0.1296	-0.1175	0.0504	-0.0797	-0.3688	0.0938	0.0379	0.0297	0.1380
Process adherance	-0.1685	-0.2066	-0.2414	-0.4045	-0.7465	-0.3282	-0.0013	-0.3139	0.0000
duration change	0.3286	-0.1178	-0.1425	-0.3296	0.0809	-0.8981	-0.1628	-0.0134	-0.5794
# of Systems	0.5761	-0.1089	-0.1703	-0.4058	-0.2075	-0.0470	0.3758	-0.1708	-0.3923
Percent Error change	-0.2629	0.0014	-0.1299	-0.1169	-0.3247	0.1675	-0.1840	-0.0553	0.2466
Hours to fix error	0.3965	-0.0819	0.0321	-0.1608	0.2271	-0.9947	-0.1604	-0.0360	-0.6957
RPA delay change	1.0000	-0.1206	-0.1820	-0.3153	0.3252	-0.3775	0.2399	-0.1493	-0.9127
Days of development	-0.1206	1.0000	-0.1394	0.1293	0.0398	0.0733	-0.0460	0.8933	0.0774
Scalabilty to other groups	-0.1820	-0.1394	1.0000	0.6264	0.1095	0.0579	-0.2176	-0.0735	0.1302
Hosting	-0.3153	0.1293	0.6264	1.0000	0.4575	0.2212	0.0834	0.2375	0.3257
Software	0.3252	0.0398	0.1095	0.4575	1.0000	-0.1909	0.0950	0.1873	-0.2810
Customer Impact	-0.3775	0.0733	0.0579	0.2212	-0.1909	1.0000	0.1532	0.0335	0.6794
Annual savings in days	0.2399	-0.0460	-0.2176	0.0834	0.0950	0.1532	1.0000	-0.1697	-0.0190
output percent improvement	-0.1493	0.8933	-0.0735	0.2375	0.1873	0.0335	-0.1697	1.0000	0.0915
Success	-0.9127	0.0774	0.1302	0.3257	-0.2810	0.6794	-0.0190	0.0915	1.0000

The correlations are estimated I

Table 9 Correlation matrix continued

Multivariate

Correlations

	termination points	Mature	frequency	P to RPA changes	manual percent change	percent waiting change	Process adherance	duration change	# of Systems	Percent Error change	Hours to fix error
termination points	1.0000	0.2058	0.2221	0.2692	0.2790	-0.0961	0.1166	-0.2090	-0.0501	0.0232	-0.0739
Mature	0.2058	1.0000	0.3130	-0.1189	-0.1501	0.1297	0.2060	-0.5539	0.1869	0.1325	-0.5181
frequency	0.2221	0.3130	1.0000	-0.2439	-0.2912	-0.0101	0.5428	-0.1561	0.3000	0.3297	-0.1914
P to RPA changes	0.2692	-0.1189	-0.2439	1.0000	0.0510	-0.1627	0.0000	0.4289	-0.2703	-0.2075	0.5812
manual percent change	0.2790	-0.1501	-0.2912	0.0510	1.0000	0.3846	-0.1736	0.1783	0.1529	0.1233	0.0798
percent waiting change	-0.0961	0.1297	-0.0101	-0.1627	0.3846	1.0000	0.1909	0.2920	0.2458	-0.1435	-0.0836
Process adherance	0.1166	0.2060	0.5428	0.0000	-0.1736	0.1909	1.0000	0.3418	0.2675	0.2241	0.2780
duration change	-0.2090	-0.5539	-0.1561	0.4289	0.1783	0.2920	0.3418	1.0000	0.1872	-0.2384	0.8870
# of Systems	-0.0501	0.1869	0.3000	-0.2703	0.1529	0.2458	0.2675	0.1872	1.0000	-0.2596	0.0461
Percent Error change	0.0232	0.1325	0.3297	-0.2075	0.1233	-0.1435	0.2241	-0.2384	-0.2596	1.0000	-0.1884
Hours to fix error	-0.0739	-0.5181	-0.1914	0.5812	0.0798	-0.0836	0.2780	0.8870	0.0461	-0.1884	1.0000
RPA delay change	-0.2144	-0.1574	-0.2606	0.0009	0.1886	-0.1296	-0.1685	0.3286	0.5761	-0.2629	0.3965
Days of development	0.2542	0.1951	-0.0634	0.6169	0.3184	-0.1175	-0.2066	-0.1178	-0.1089	0.0014	-0.0819
Scalabilty to other groups	0.4583	0.1551	-0.1391	0.2093	0.0688	0.0504	-0.2414	-0.1425	-0.1703	-0.1299	0.0321
Hosting	0.1572	0.4166	-0.2268	0.2335	-0.1663	-0.0797	-0.4045	-0.3296	-0.4058	-0.1169	-0.1608
Software	-0.3221	-0.3594	-0.4975	0.1567	-0.0449	-0.3688	-0.7465	0.0809	-0.2075	-0.3247	0.2271
Customer Impact	0.1093	0.5311	0.1605	-0.5684	-0.0464	0.0938	-0.3282	-0.8981	-0.0470	0.1675	-0.9947
Annual savings in days	-0.0425	0.2229	-0.1297	-0.2734	0.0521	0.0379	-0.0013	-0.1628	0.3758	-0.1840	-0.1604
output percent improvement	-0.0985	0.1350	-0.1971	0.6061	0.2153	0.0297	-0.3139	-0.0134	-0.1708	-0.0553	-0.0360
Success	0.1609	0.2843	0.2539	-0.2789	-0.1786	0.1380	0.0000	-0.5794	-0.3923	0.2466	-0.6957

The correlations are estimated by Row-wise method.

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In the pursuit of digital transformation, the Air Force creates digital airmen. Digital airmen are robotic process automations designed to eliminate the repetitive high-volume low-cognitive tasks that absorb so much of our Airmen's time. The automation product results in more time to focus on tasks that machines cannot sufficiently perform data analytics and improving the Air Force's informed decision-making. This research investigates the assessment of potential automation cases to ensure that we choose viable tasks for automation and applies multivariate analysis to determine which factors indicate successful projects. The data is insufficient to provide significant insights.

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