

# **Programmable Robotic Process Automation Modelling of Software Process**

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## **ABSTRACT**

In Software engineering certain functions in the back-end can be performed by software robotic process. These activities are often triggered by humans from a user interface or via an API such as placing a trade in exchange trading, extracting data, filling out forms, moving files and so on. Robotic Process Automation, use automation technology to replicate these human functions integrating and performing repetitive operations between enterprise and productivity applications. In this paper an extensive review of how a software or programmable model can be built to handle these operations and looking at existing models and challenges in them that can be improved upon. It explores how a software bot combines a combination of automation, computer vision, and machine learning to automate rule-based and trigger-driven repetitive, high-volume tasks. How programmable software systems can deploy scripts that mimic human processes are also evaluated. It will examine how these automation process employs rule-based software to carry out high-volume business process activities, freeing up human resources to focus on more complicated work. It also reviews how software engineering special tools can be used for planning, engineering, designing and reuse of the Robotic Process Automation applications or software systems.

## **General Terms**

Programmable Robotic Process Automation, Software engineering tools, API, user interfaces and Model design

## **Keywords**

Programmable, Robotic Process Automation, Model, software bot, exchange trading, data extraction

## **1. INTRODUCTION**

Robotic Process Automation (RPA), use automation technology to replicate back-office functions performed by humans, such as extracting data, filling out forms, moving files, and so on. It integrates and performs repetitive operations between enterprise and productivity applications via APIs and user interface (UI) interactions.

RPA is more than a trend and can be defined even in simple terms as a technique in which a software bot combines a combination of automation, computer vision, and machine learning to automate rule-based and trigger-driven repetitive, high-volume tasks. RPA solutions automate the execution of numerous tasks and transactions across disparate software systems by deploying scripts that mimic human processes. This type of automation employs rule-based software to carry out high-volume business process activities, freeing up human resources to focus on more complicated work. RPA enables CIOs and other decision-makers to speed their digital transformation initiatives and increase their staff's return on

investment (ROI).

The purpose of this article is to outline the robotic process automation processes, its uses, benefits and provide an outlook on the process. This topic was chosen because of its wide applicability and this topic will guide the researcher on improvements in the process, that may be applicable to life. In addition, how best can RPA be integrated into the daily lives of regular citizens.

RPA is a method of automating operations that falls under a broad category of process automation technologies, each of which is tailored to specific processes and goals (Willcocks et al. 2016). RPA serves as a transition factor between human work and comprehensive business process automation in cases when human labor or the creation and integration of business process management systems (BPMS) are too expensive or not justified by business demands (Santos et al. 2020). As a result, so-called software robots gain access to systems and execute duties that are comparable to or imitate those of humans (Lacity et al. 2016). RPA-assisted process automation can also refer to the automation of specific activities or even tasks. For example, a software robot might launch a new instance of Microsoft Excel, navigate to a specified spreadsheet, update values in specific cells, and save the file before shutting the program. RDA, as contrast to RPA, which automates procedures in an unattended manner, focuses on assisting humans in duties such as front-office functions (Syed, 2020). RPA and RDA, however, do not have wholly opposite conceptions or goals. RPA assists mechanical engineering businesses by allowing staff to focus on more vital aspects of the business instead of completing tedious, repetitive jobs. RPA also boosts speed and efficiency while eliminating human error. RPA uses seamless automation technologies to ensure that operational operations are carried out precisely, much way modern mechanical engineering does with robots to assemble items.

## **1.2 Components of RPA**

Three software components typically make up an RPA environment. They're known as software robots or RPA bots. Depending on the company goals, the configuration of these pieces may vary. In fact, only two components are required: a studio where a developer can design automation scenarios, and a bot that can execute the available scenarios on demand. For smaller businesses, this combination is frequently sufficient. On the other hand, enterprise-level businesses require a full three-tier design to manage various sophisticated automation workflows and integrations. Three main components will be outlined. First component are the Bots. An RPA workhorse is a bot. RPA bots automate repetitive, rule-based operations including filling out forms, invoicing, and data transfer between systems. The jobs that bots may perform are growing increasingly complicated as artificial intelligence progresses and may involve optical character recognition (OCR) and

natural language processing. RPA bots may handle a variety of processes, ranging from simple to complicated. RPA is typically used to automate linear rule-based processes like completing surveys, filling out forms, invoicing, and so on. The second component is a studio / bot designer. A studio is a place where bots are built and configured. Studio capabilities and interfaces differ from one manufacturer to the other. There are RPA tools with a high learning curve and stringent background requirements. There are, however, several very user-friendly editors with visual drag-and-drop user interfaces that don't require sophisticated programming knowledge. Activities are the building elements of RPA workflows; they allow bots to accomplish all the tasks required to automate business operations. Some of the activities includes opening and closing apps or windows, clicking on elements, data input and reading, writing, and updating spreadsheets. Finally, Orchestrator. RPA's brain is an orchestrator. It unifies all robotic process automation solutions under one roof and provides general management and control. The orchestrator is a robotic process automation management tool. The orchestrator is a one-stop shop that accepts and distributes all allocated tasks to the bots. It's triggered by incoming emails or new documents added to a folder, for example. It examines the bots that are currently accessible, monitors their workload, and then assigns the assignment to an unoccupied bot or waits for the bot to finish its current task before proceeding. The orchestrator's key benefit is that it allows firms to use RPA across teams. Assume there are three departments that use automation: DevOps, Sales, and Human Resources. Without an orchestrator, the teams would have their own automation workflows, which would require separate bots and deployment and maintenance processes. It is possible to share and reuse resources with the orchestrator. As a result, the company's RPA productivity, ROI, and automation flow are all unified. In addition to running the bots, an orchestrator can: provide centralized management of projects, store automation scenarios settings, schedule bot launches, make multiple bots work together, connect bots to third-party apps, monitor statuses of bots and view logs, etc.

## **2. ROBOT**

Modern robot is a programmable machine capable of carrying out a complex series of actions automatically. Some believe that only hardware robots are actually robots, but robots can actually be hardware or software ("bots", robotic process automation, user-agents ). A robot can be guided by an external control device, or the control may be embedded within. Robots are widely used in such industries as automobile manufacture to perform simple repetitive tasks, and in industries where work must be performed in environments hazardous to humans (Sutikno, 2023). Many aspects of robotics involve artificial intelligence; robots may be equipped with the equivalent of human senses such as vision, touch, and the ability to sense temperature.

Robotics is a discipline that has had amazing growth and development over the past few decades, and this growth and development is continuing at a rapid pace. With new ideas being generated on a consistent basis, it may be challenging to keep up with the most recent developments and trends in the industry. The term "robotics technology" refers to a subfield of engineering and computer science that focuses on the creation, development, and implementation of computer-controlled machines. One definition of a robot is a machine that is capable of doing a variety of tasks on its own, typically by interacting with its environment and making decisions based on the information it receives from its senses (Budiayanta and Sereati, 2020). Artificial intelligence (AI), computer science, electrical

engineering, and mechanical engineering are some of the fields that have contributed to the development of robotic technology. In the twenty-first century, significant advancements in robotics technology have been made possible by the introduction of AI, machine learning (ML), and other cutting-edge technologies. There are already numerous industries that are beginning to include robots into their operations, such as the medical industry, agriculture, transportation, and even space exploration. They are able to manage a wide variety of activities, ranging from simple repetition to complex decision-making and problem-solving, and they work in a variety of contexts, including hospitals and factories. There is expected rise in the incorporation of robots into our everyday lives as technology continues to improve, which will result in a transformation of how we live, interact, and work (Santos et al., 2023).

The goal of robotic technology is to create machines that are capable of performing tasks in a manner that is more proficient, secure, and efficient than any other equipment or person (Zainuddin et al., 2022)

Robotics has a wide range of applications, some of which include medical robots, autonomous vehicles, drones, self-driving cars, and space exploration. Some recent developments in the field of robotics include software robots which include web bots, crawlers, RPA, software-agents.

## **2.1 Robotics and Automation**

The origins of the concept of robotics may be traced back to ancient civilizations. The first examples of automata can be found in Greek mythology and Chinese culture. On the other hand, the first industrial robots did not come into existence until after the 1950s, which marked the beginning of a new era in the field of robotics. These early robots were enormous and heavy, and their primary application was in manufacturing environments, where they were utilized for operations, such as welding and painting. As time has progressed, robots have undergone major advancements, becoming more intelligent, sophisticated, and flexible. Additionally, the development of microprocessors and sensors has enabled them to carry out jobs that are more difficult (Abualhija et al., 2023).

## **3. ROBOTIC PROCESS AUTOMATION**

The invention of the computer solved the problem of working with data, extracting information from processed data and performing many computer based activities. However, a human was still required to operate the machine. Now, ever-evolving technology will allow humans to be removed from the equation as well. Robotic Process Automation (RPA) is a form of business process automation technology driven by software bots. It helps businesses automate their processes in such a way that manual tasks are optimized and the process remains uninterrupted. These manual tasks could range from data extraction to invoice processing, handling portal queries to maintaining consumer data, validating or reviewing operations to streamlining supply chain information. Below is an account of the key predecessor technologies that led to the evolution of RPA as a discrete technology, different from traditional automation (Photon, 2020).

Robotic Process Automation (RPA) use automation technology to replicate back-office functions performed by humans, such as extracting data, filling out forms, moving files, fixing a trade on exchanges and so on. It integrates and performs repetitive operations between enterprise and productivity applications via APIs and user interface (UI) interactions. RPA is more than a trend and can be defined even in simple terms as a technique in

which a software bot combines a combination of automation, computer vision, and machine learning to automate rule-based and trigger-driven repetitive, high-volume tasks (Santos et al., 2023). RPA solutions automate the execution of numerous tasks and transactions across disparate software systems by deploying scripts that mimic human processes. This type of automation employs rule-based software to carry out high-volume business process activities, freeing up human resources to focus on more complicated work. RPA enables CIOs and other decision-makers to speed their digital transformation initiatives and increase their staff's return on investment (ROI).

There is a need to outline the robotic process automation processes, its uses, benefits and provide an outlook on the process. In addition, how best can RPA be integrated into the daily lives of regular citizens. RPA is a method of automating operations that falls under a broad category of process automation technologies, each of which is tailored to specific processes and goals (Willcocks et al. 2016). RPA serves as a transition factor between human work and comprehensive business process automation in cases when human labour or the creation and integration of business process management systems (BPMS) are too expensive or not justified by business demands (Syed, 2020). As a result, so-called software robots gain access to systems and execute duties that are comparable to or imitate those of humans (Lacity et al. 2015). RPA-assisted process automation can also refer to the automation of specific activities or even tasks. For example, a software robot might launch a new instance of Microsoft Excel, navigate to a specified spreadsheet, update values in specific cells, and save the file before shutting the program. RPA, as contrast to RPA, which automates procedures in an unattended manner, focuses on assisting humans in duties such as front-office functions. RPA and RDA, however, do not have wholly opposite conceptions or goals. RPA assists mechanical engineering businesses by allowing staff to focus on more vital aspects of the business instead of completing tedious, repetitive jobs. RPA also boosts speed and efficiency while eliminating human error. RPA uses seamless automation technologies to ensure that operational operations are carried out precisely, much way modern mechanical engineering does with robots to assemble items.

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interfaces differ from one manufacturer to the other. There are RPA tools with a high learning curve and stringent background requirements. There are, however, several very user-friendly editors with visual drag-and-drop user interfaces that don't require sophisticated programming knowledge. Activities are the building elements of RPA workflows; they allow bots to accomplish all the tasks required to automate business operations. Some of the activities includes opening and closing apps or windows, clicking on elements, data input and reading, writing, and updating spreadsheets. Finally, Orchestrator. RPA's brain is an orchestrator. It unifies all robotic process automation solutions under one roof and provides general management and control. The orchestrator is a robotic process automation management tool. The orchestrator is a one-stop shop that accepts and distributes all allocated tasks to the bots. It's triggered by incoming emails or new documents added to a folder, for example. It examines the bots that are currently accessible, monitors their workload, and then assigns the assignment to an unoccupied bot or waits for the bot to finish its current task before proceeding. The orchestrator's key benefit is that it allows firms to use RPA across teams. Assume there are three departments that use automation: DevOps, Sales, and Human Resources. Without an orchestrator, the teams would have their own automation workflows, which would require separate bots and deployment and maintenance processes. It is possible to share and reuse resources with the orchestrator. As a result, the company's RPA productivity, ROI, and automation flow are all unified. In addition to running the bots, an orchestrator can: provide centralized management of projects, store automation scenarios settings, schedule bot launches, make multiple bots work together, connect bots to third-party apps, monitor statuses of bots and view logs, etc.

### 3.2 RPA a Historical Perspective

**Screen scraping software:** The first technology that bridged the gap between digital and legacy systems was primarily used for data mining, web indexing, web mining, and online price monitoring and comparison.

**Artificial intelligence:** The capability of digital systems to perform tasks that require human intervention and intelligence. The applications of AI can already be seen through textual analysis and Natural Language Processing, which are heavily used in customer service.

**Workflow automation & management tools:** It is the design, execution, and automation of processes based on workflow rules. Significant improvement in efficiency, productivity, and accuracy can be seen in these manual processes by implementing workflow

**Screen scraping software:** Screen scraping technology is considered as a significant step towards the creation of RPA. It was the first technology that created a bridge between digital

systems and incompatible legacy systems. It helps gather data or information from the web, programs, or documents. However, due to limitations and lack of availability of source codes, programmers, and documentation, it became difficult to understand for the average business user. **Workflow automation and management tools:** Workflow automation reduces human tasks by integrating a series of automated actions into repetitive business processes. These actions must be repetitive so that their steps are predictable. Workflow automation software can aid in order processing by capturing particular fields of interest—such as customer information, invoice details, and orders placed—and then translating them into the company's database and notifying the corresponding employee.

Artificial intelligence (AI) refers to the capability of computer systems to perform tasks that normally require human intervention and intelligence. What makes RPA such an impactful technology is its ability to be augmented with artificial intelligence to learn and adapt over a period of time to react to varying tasks that are considered tedious, time-consuming manual labor.

**The Emergence of RPA:** RPA is a developing technology that still relies on its predecessor technologies—AI, screen scraping, and workflow automation. Rather than being dependent on code as is required for screen scraping, RPA software allows users to establish automation

and manage workflows using drag and drop features. While automation streamlines repetitive, rules-based business processes, the software is mostly unable to deal with exceptions independently. AI, along with automation software, can be leveraged to streamline complex decision-making and analysis, leveraging Natural Language Processing (NLP), recommendation services, and online customer support. 81% of companies say that the cloud has greatly enhanced or moderately enhanced their efforts around automation. The advantages of cloud-native, intelligent RPA deployments are immense. A cloud-native RPA operates as a self-service technology accessed via a web-based graphical interface from anywhere. It is simple to use and scale, and works with all applications.

The sudden need for remote work has accelerated the enterprise's use of automation. Reliance on manual processing has exposed inefficiencies in legacy systems. RPA and hyper-automation are among the top advanced technologies that will change the future of business.

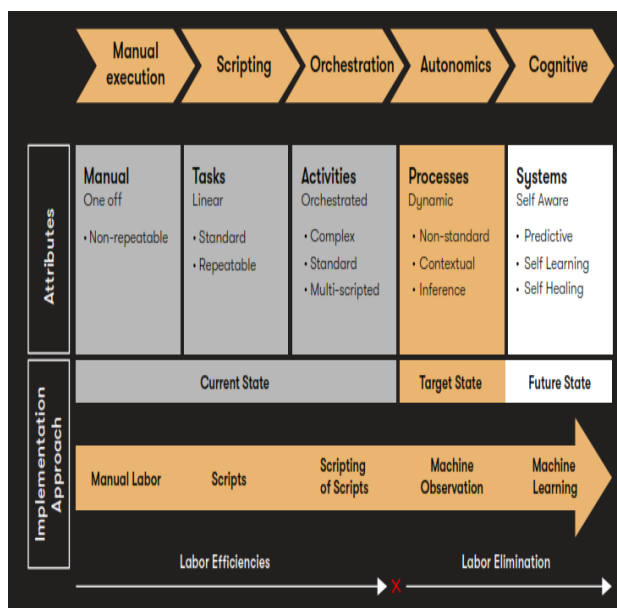


Fig.1: Evolution of Automation (source: Photon 2020)

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### 3.4 Factors of RPA

When it comes to process automation, numerous factors must be considered, including organizational competencies, financial resources, and time constraints. To date, a process is especially ideal for RPA if it follows a standardized, rule-based structure (i.e., does not need cognitive or judgment effort), is performed frequently and manually by humans, and requires access to various systems (Aguirre and Rodriguez, 2017). RPA is frequently used to automate back-office tasks because they share similar properties (Aguirre and Rodriguez 2017). Repetitive operations such as periodic reporting (including some sort of data analysis), data entry, bulk email creation, archiving, and data format and graphics conversion are examples of these processes. RPA promises to improve process performance, efficiency, scalability, auditability, security, and compliance while being easy to implement at a low cost when compared to traditional process automation (Lacity and Willcocks 2016). RPA may thus aid in the improvement of process key performance indicators (KPIs), even though

software robots do not improve processes. If software robots perform established process flows based on inefficient or error-prone processes, they will likewise conduct inefficient process steps, resulting in additional costs and resource waste. Prior to automating a process, it is critical to improve and optimize it. It is critical to maintain RPA improvements once they have been deployed, in addition to revamping the process beforehand. Following the Six Sigma methodology (Linderman et al. 2003), one may establish a maximum error rate for the software robot to remain functional. These characteristics make it possible to distinguish between software robots that are used for simple screen scraping and those that are used to identify fraud, for example.

Therefore, RPA relates to the current and future trends of the world. The need for leaner processes is always welcome in every industry. Assuring the efficiency of contemporary manufacturing lines ensures that the entire production process runs smoothly. A production process that begins inefficiently has the potential to wreak havoc on all subsequent operations. This complicates the customer support process while also posing production challenges such as material shortages and production delays. RPA systems can automate operations like writing production reports, inventory management, and bill of materials to improve the productivity of production lines.

### 3.5 Challenges of RPA

While RPA software can aid an organization's growth, it faces significant challenges, including organizational culture, technological concerns, and scaling. While RPA may eliminate the need for some employment roles, it will also spur the creation of new ones to handle more complicated tasks, allowing employees to focus on higher-level planning and problem-solving. As responsibilities within job positions alter, organizations will need to foster a culture of learning and innovation. The flexibility of a workforce to adapt will be critical to the success of automation and digital transformation programs. You may prepare your teams for ongoing shifts in priorities by educating your employees and investing in training programs. Scaling difficulty. While RPA can conduct numerous processes at the same time, it can be challenging to scale in an organization owing to regulatory changes or internal changes. According to Forrester research, 52% of consumers say growing their RPA program is difficult. To qualify as an advanced program, a corporation must have 100 or more active working robots, yet few RPA programs go past the first ten bots.

The implementation of RPA will boost the economy on the local, national, and international level. RPA allows humans and robots to perform exactly what they are best at. Employees can focus more on client and customer engagement, relationship management, and other things where people naturally excel because RPA frees them from monotonous chores. Better business comes from delighted clients and customers. There is more versatility. RPA can be used in a variety of businesses and can do a variety of jobs. Any process that is rule-based, defined, and repeatable is a good candidate for automation. RPA increases the service desk's operational excellence and monitors the network. This allows businesses to absorb short-term spikes without having to hire or educate more employees.

## 4. RPA MODELS

RPA (Robotic Process Automation) Models are classified into three primary types based on human interaction- Attended, unattended and Hybrid- which automate repetitive, rule-based tasks to improve efficiency. Attended bots assist users, unattended bots operate independently, and hybrid models

combine both for end-to-end automation, often deployed via cloud or on-premise infrastructure. Early RPA technologies relied heavily on screen scraping and data extraction techniques to interact with existing software systems. These foundational technologies enabled RPA bots to perform repetitive tasks by mimicking user interactions with software interfaces. RPA models have been increasingly intelligent by integrating artificial intelligence (AI), machine learning (ML), and optical character recognition (OCR) to handle unstructured data, enhancing decision-making capabilities. As RPA technology matured, intelligent automation emerged as a significant advancement. Intelligent automation combines traditional RPA with AI-driven insights, leveraging machine learning and natural language processing (NLP) to optimize processes and improve decision-making.

### 4.1 Attended RPA Model

Attended RPA (Robotic Process Automation) is a collaborative model where software robots act as digital assistants on an employee's workstation, triggered by user actions to handle routine tasks in real-time. These bots work alongside humans, ideal for front-office tasks requiring human judgment, such as customer service, data entry, or verification. While RPA automates repetitive, rule-based tasks in the background, APA focuses on tasks that require contextual judgment or human approval. An attended bot might fill out a form, fetch data from multiple systems, or suggest next steps - but the human decides when to start, stop, or confirm the action.

APA is widely used in **customer support, claims processing, IT service desks, and financial operations**, where speed and accuracy matter but compliance still demands a person's review. Modern APA platforms embed automation widgets, sidebars, or "copilot" panels directly into business applications, allowing employees to invoke automations without leaving the interface they're using.

APA brings Robotic Process Automation (RPA) to the user's desktop or browser, letting employees trigger, guide, or collaborate with bots directly inside their daily workflows. It's sometimes called **human-in-the-loop automation** - a bridge between fully manual work and fully autonomous processes.

#### Key Aspects of Attended RPA:

**i) Human-in-the-Loop:** Employees initiate the automation or provide input for the bot to complete tasks.

**ii) Desktop-Based:** Operates on the user's local machine, interacting with front-end applications, browsers, and desktop tools.

**iii) Improved Efficiency:** Reduces time spent on repetitive tasks (e.g., toggling between screens in call centers).

**iv) Trigger Types:** Can be initiated by a button click, a keyboard shortcut, or a specific user action.

## Architecture for Robotic business process automation (RPA)

This slide showcases the use of robotic process automation architecture and digital workers to automate easy tasks. It includes elements such as public network, cloud network and enterprise network.

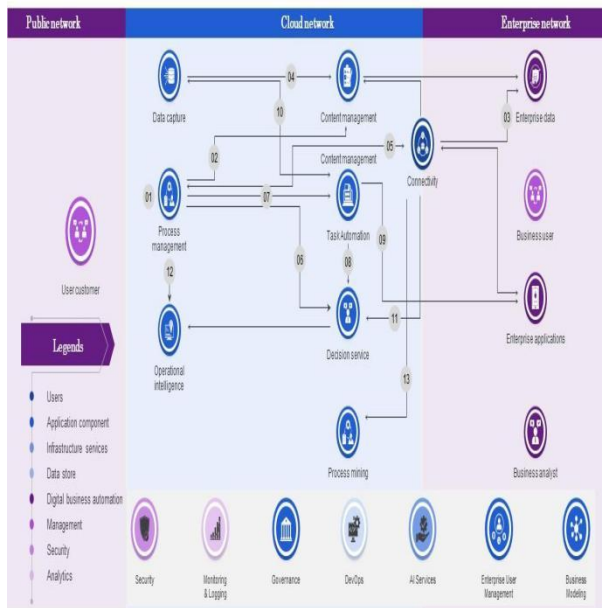


Fig. 2: An Attended RPA Model Architecture

### Key Differences from Unattended RPA:

**a)Initiation:** Attended robots are triggered by a user. Unattended robots run independently, often scheduled on servers.

**b)Use Case:** Attended is best for "front-office" tasks requiring human interaction, while Unattended suits "back-office" batch processing.

### Common Use Cases:

**a)Customer Service:** Instantly gathering customer data across systems to help service representatives (e.g., at call centers).

**b)Data Entry:** Pre-filling forms and handling data validation.

**c)Document Processing:** Extracting data from documents and passing it to the user for validation.

## 4.2 UnAttended RPA Model

An **unattended RPA** (Robotic Process Automation) model is an "always-on," automated workforce where software robots execute end-to-end business processes independently without requiring human initiation or supervision. Operating in the background (often on virtual machines), these bots run 24/7/365 to handle repetitive, high-volume, rules-based tasks.

Instead of requiring an employee to click a button, unattended bots rely on specific triggers or pre-set schedules to execute tasks:

**Schedule-Based:** Bots execute tasks at designated times (e.g., generating end-of-day financial reports at midnight).

**Event-Driven:** Bots monitor data streams, email inboxes, or shared network folders and immediately begin processing once a new file or request is detected.

Unattended bots operate independently, often accessing multiple systems and databases to execute tasks. Given their autonomy, these bots typically require high-level access permissions, making them prime targets for malicious actors.

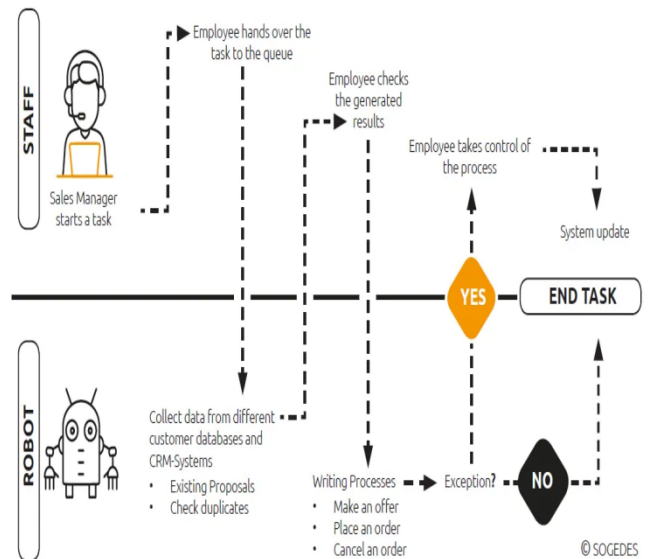


Fig. 3: UnAttended Robotic Process Automation

The primary security concerns for unattended bots include credential theft, unauthorized access, and the potential for data breaches. Since unattended bots operate without human oversight, any compromised bot can execute malicious actions without immediate detection. This is particularly concerning for organizations handling sensitive data, as a security breach in an unattended bot can lead to unauthorized data exposure or manipulation. To mitigate these risks, organizations should implement strong authentication mechanisms, such as multi-factor authentication (MFA), to secure bot credentials. Encryption of data in transit and at rest is essential to protect sensitive information accessed by unattended bots. Regular audits of bot activity logs can help detect unusual patterns, providing an opportunity to intervene in case of suspicious behavior. Additionally, role-based access control (RBAC) can limit the permissions granted to unattended bots, restricting their access to only the systems and data necessary for their tasks.

Another critical aspect of unattended bot security is system isolation. By restricting bots to isolated virtual environments, organizations can prevent unauthorized access to broader network systems. This containment strategy helps to minimize the impact of any security breach, limiting potential damage to specific areas within the network.

### Typical Use Cases

The unattended model is perfectly suited for back-office operations that require continuous data processing. Common examples include:

- i) Invoice processing and accounts payable.
- ii) Claims management and data entry.
- iii) Employee onboarding workflows.
- iv) Legacy system data migration.

### Key Components of the Architecture

Running automations without a user present requires specialized infrastructure and distinct software elements:

**i) Centralized Orchestration:** Software like Microsoft Power Automate or UiPath Orchestrator is used to deploy, schedule, and monitor the robots.

**ii) Dedicated Environments:** Bots usually run on virtual

machines (VMs) rather than a person's daily workstation, ensuring that bot activity doesn't interrupt human workers and vice versa.

- iii) **Robust Security:** Unattended machines must be set up to bypass screen locks securely while logging execution times and handling exceptions automatically.

#### Advantages

- i) **Scalability:** Bots can run continuously, doing the work of multiple full-time employees in a fraction of the time.
- ii) **Zero Interruptions:** Employees are completely freed from tedious, mundane tasks, allowing them to focus on high-value, customer-facing work.
- iii) **Consistent Accuracy:** Eliminates human data entry errors completely.

#### Disadvantages/Challenges

- i) **Infrastructure Costs:** Requires investment in virtual machines, dedicated server environments, and specialized licensing.
- ii) **Maintenance:** Because bots interact with user interfaces (like a human would), changes to third-party apps or websites can break the automation.

For a visual demonstration of how unattended desktop flows are managed and scaled across virtual machines to handle high-volume data:

### 4.3 Hybrid RPA Model

A **Hybrid RPA model** seamlessly blends human-machine collaboration by integrating *attended* and *unattended* robotic process automation into a single workflow. Unattended bots work autonomously on background tasks, while attended bots assist human workers in real-time, passing off complex exceptions for human judgment.

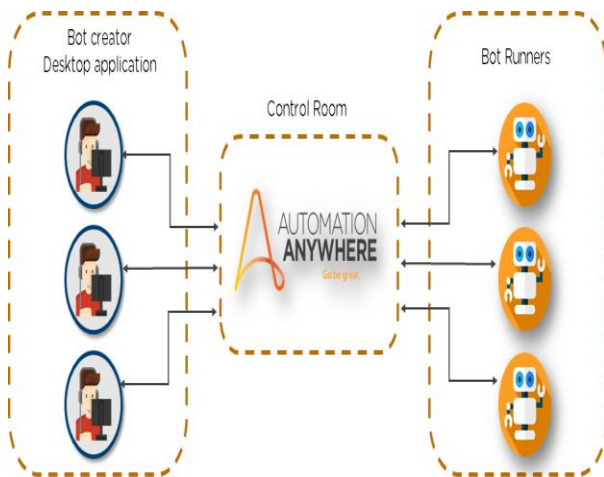


Fig 4: Hybrid Robotic Process Automation

#### Key Components of Hybrid RPA

- i) **Unattended Bots:** unattended Bots is part of a hybrid RPA and it work together with attended bots to make a complete hybrid system.
- ii) **Attended Bots:** Act as digital assistants and trigger human action to help the unattended bot to work in the desired way, like human taking over from an agent on a live phone call when the need arise.

- iii) **Human-in-the-Loop:** When a bot encounters an unverified document or a decision that requires nuanced judgment, the hybrid model pauses the automation and routes the task to a human employee for review.

#### Common Use Cases

- i) **Insurance Claims Processing:** Unattended bots process standard claims, extract data, and flag suspicious or high-value claims for human adjusters to evaluate.
- ii) **Customer Support Chatbots:** Bots initially interact with customers to resolve basic queries. If the issue requires an escalation, the bot hands the session over to a human service agent while providing the agent with the customer's background context.
- iii) **IT Ticket Triage:** Back-office bots organize and route incoming support tickets, while attended bots assist IT staff by automatically running diagnostics and populating resolution notes.

#### Benefits

- i) **Scalability:** Organizations can achieve end-to-end automation rather than just automating isolated tasks.
- ii) **Reduced Errors:** Routine, fatigue-prone data transfers are eliminated, allowing humans to focus on high-value, strategic work.
- iii) **Enhanced Agility:** Processes become highly adaptable, seamlessly bridging the gap between front-end customer interaction and back-end processing.

### 4.4 Methodology

The methodology for evaluating Robotic Process Automation (RPA) implementations requires a multifaceted approach that combines technical assessment with organizational impact analysis. RPA researches may employ a single or mixed-methods design incorporating both quantitative metrics and qualitative insights to develop a comprehensive understanding of RPA efficacy across different operational contexts. The investigation begins with a comparative analysis of leading RPA platforms, examining their technical architectures, automation capabilities, integration potential, and governance features. This analysis establishes a foundation for understanding how platform-specific characteristics influence implementation outcomes and organizational value realization. The evaluation considers factors such as development environment usability, bot orchestration capabilities, cognitive processing features, and security frameworks, providing a systematic assessment of how different technological approaches address varying business requirements. Case selection follows a purposive sampling approach targeting organizations in the finance and healthcare sectors that have implemented RPA solutions for at least twelve months. Comprehensive analysis of the full automation lifecycle the methodology specifically considers the varying degrees of process standardization and complexity across organizations, recognizing that RPA implementation challenges differ substantially between highly structured environments and those with greater process variability and exception handling requirements.

Figure 5 show three components in the system the Financial sector component, Health care Component and the RPA implementation value framework. This framework enables consistent measurement across diverse implementation contexts while accommodating sector-specific variations in

process requirements and success criteria. Specific metrics include cycle time reduction, processing capacity increases, accuracy improvements, exception handling effectiveness, implementation timeline adherence, and total cost of ownership. The framework also incorporates measures of employee satisfaction, skill development, and work reallocation to capture the human dimension of automation implementation. The research employs process mining techniques to analyze automated workflows, identifying optimization opportunities and bottlenecks that impact performance. This analytical approach acknowledges that RPA implementations exist within complex socio-technical systems where technical capabilities interact with organizational structures, employee skills, and business processes to determine ultimate effectiveness. Prior research has demonstrated that successful RPA implementation requires analytical frameworks that can account for this complexity and provide insights that address both technical configuration and organizational integration challenges across the automation lifecycle

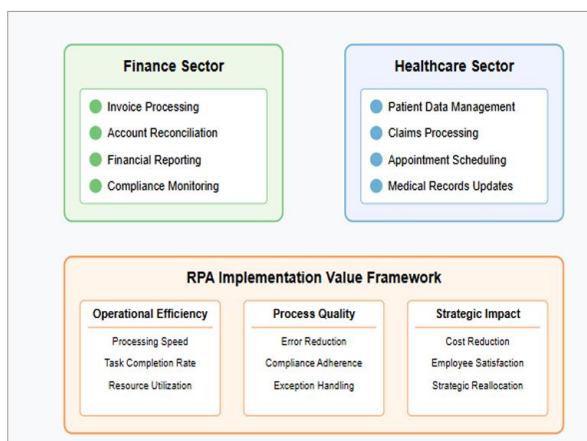


Fig. 5: Sample Methodology Framework (Vijay, 2025)

#### Discussion: Challenges, Issues and Limitations

While robotic process automation offers significant potential for operational improvement, its implementation presents multifaceted challenges that organizations must navigate to realize sustainable benefits. Technical integration barriers with legacy systems represent one of the most persistent obstacles to successful RPA deployment, particularly in organizations with complex, fragmented IT landscapes developed over decades. These legacy environments typically lack standardized interfaces, comprehensive documentation, and consistent data structures, creating significant complexity for RPA implementation. The RPA application in various services was illustrated in figure 6. Bots designed to interact with user interfaces must adapt to variations in screen layouts, field positioning, and response times that characterize many legacy applications.

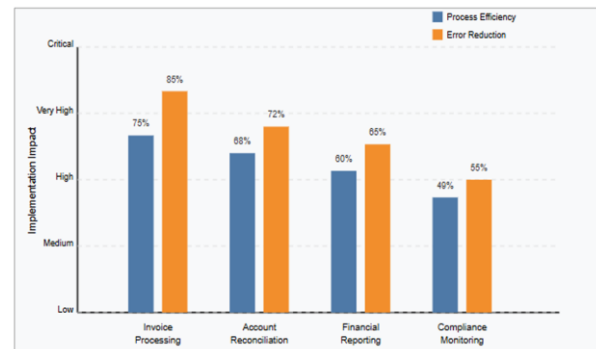


Fig. 6: RPA application in various services (Vijay, 2025)

Case studies of large enterprises implementing RPA have documented numerous instances where automation projects exceeded both budget and timeline projections due to unforeseen integration complexities with legacy systems. The challenge is particularly acute in sectors like banking, insurance, and telecommunications where mission-critical operations often run on mainframe systems with customized interfaces and limited API accessibility. Research demonstrates that successful organizations develop systematic approaches to application interface analysis before implementing RPA, creating detailed documentation of screen elements, response patterns, and exception scenarios to facilitate more resilient bot design (Antiaño and Alejandro, 2026). Organizational resistance and workforce adaptation concerns present equally significant challenges for RPA implementation. Employee concerns regarding job displacement can undermine adoption efforts and create cultural resistance that impedes successful deployment. This resistance manifests through various mechanisms including reluctance to share process knowledge, heightened scrutiny of automation errors compared to human mistakes, and political opposition to process standardization efforts that enable automation. The most successful implementations incorporate comprehensive stakeholder engagement strategies that begin during the earliest planning phases and continue throughout deployment. These approaches include transparent communication about automation objectives, involvement of operational staff in process selection and redesign, and clear articulation of how human roles will evolve in an automation-enabled environment. Research has demonstrated that organizations achieving the highest returns from RPA implementation typically invest significantly in preparing their workforce through education programs that build understanding of automation capabilities, limitations, and implications for day-to-day operations. Process standardization requirements for successful implementation represent a third significant challenge area, as RPA technology functions optimally with consistent, well-documented processes that follow predictable patterns. Many organizations discover during implementation that their ostensibly standardized processes actually contain numerous variations, exceptions, and workarounds that have evolved over time to address specific business needs or system limitations. These process inconsistencies create substantial challenges for RPA implementation, requiring either extensive process reengineering before automation or complex bot logic to handle multiple process variations. Studies of implementation failures have frequently identified inadequate process analysis as a primary contributor, with organizations discovering mid-implementation that processes contained significantly more decision points and exceptions than initially documented. This discovery often necessitates substantial rework of automation solutions, contributing to cost overruns and deployment delays.

Research into successful implementations has identified process mining and simulation techniques as valuable approaches for identifying variation before automation design begins. These techniques enable more accurate assessment of process standardization requirements and potential automation complexity, allowing organizations to make informed decisions about process redesign versus exception handling through bot logic (Antiago and Alejandro, 2026)[7]. Security and compliance considerations present additional dimensions of implementation complexity, particularly in highly regulated industries such as financial services and healthcare. RPA bots typically require broad system access privileges to perform their functions, creating potential security vulnerabilities if access credentials are not properly managed. Studies of mature implementations have documented the effectiveness of establishing dedicated RPA governance frameworks that integrate with existing security and compliance structures while addressing automation specific concerns. These governance frameworks typically include controls for bot access management, change control procedures, exception handling protocols, and comprehensive audit mechanisms that ensure automated processes remain fully compliant with regulatory requirements even as they evolve over time. Limitations in handling exceptions and unstructured data represent significant technical constraints that affect RPA's applicability across business processes. Traditional RPA excels with structured data and predictable process paths but struggles with exceptions that require judgment, contextual understanding, or adaptation to novel situations. Similarly, many business processes involve unstructured inputs such as emails, documents, or images that standard RPA tools cannot easily interpret without additional cognitive capabilities. These limitations constrain automation potential for processes with high exception rates or significant unstructured data components. Case studies of implementation efforts have documented numerous instances where organizations attempted to automate processes with exception rates or unstructured data volumes that exceeded RPA's practical capabilities, resulting in unstable automation solutions that required frequent human intervention. Research into successful implementations has identified the importance of establishing clear criteria for process selection that consider both exception frequency and data structure characteristics. Organizations achieving the highest returns typically focus initial efforts on processes with structured inputs, well-defined business rules, and manageable exception volumes, gradually expanding to more complex scenarios as they develop greater implementation expertise (Antiago and Alejandro, 2026). Cost-benefit analysis challenges represent a final significant barrier to effective RPA implementation, as organizations frequently struggle to accurately quantify both implementation costs and expected benefits. Initial cost projections often focus on technology licensing while underestimating expenses related to process analysis, configuration, testing, and change management. Similarly, benefit estimates typically emphasize direct labor savings while overlooking more difficult-to-quantify impacts on process quality, compliance, customer experience, and employee satisfaction. This imbalanced analysis creates unrealistic expectations that can undermine program sustainability when anticipated returns fail to materialize within expected timeframes. Studies of large-scale RPA programs have documented that organizations often underestimate the total cost of implementation by failing to account for expenses beyond software licensing, including process documentation, exception handling design, testing across multiple scenarios, integration with existing systems, and ongoing maintenance as business processes and

applications evolve. Research examining mature RPA implementations has identified the importance of developing multidimensional business cases that capture both quantitative benefits such as processing time reduction and qualitative improvements in areas such as compliance adherence, data quality, customer satisfaction, and employee experience. Organizations that establish comprehensive measurement frameworks aligned with strategic objectives typically achieve more sustainable automation programs than those focusing exclusively on headcount reduction metrics (Mary,2026).

## **5. CONCLUSION**

In conclusion programmable Robotic Process Automation modelling of Software process have been presented. It examined various models currently used in RPA and how a software process via bot can combine automation, computer vision, and machine learning to automate rule-based and repetitive high-volume tasks. How programmable software systems can deploy scripts that mimic human processes are also evaluated. The model also examine how these automation process employs rule-based software to carry out high-volume business process activities, freeing up human resources to focus on more complicated work. The design and reuse of the Robotic Process Automation applications or software process stands to benefit.

## **6. RECOMMENDATION**

In this paper we have analyzed robotic process automation and its programmability how it can be applied in different areas of modern software activities proposed an integration of advanced intelligence models to it. This paper recommend the use of these models in building software robots that can automate activities carried out in various office places as well as in finance organizations were many activities are either manual or semi-automated. This can be achieved by modelling software robots to function like its hardware counterpart carrying out tasks that can assist offices and organizations in the fast paced world of today.

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