Journal of Intelligent Systems and Control
https://www.acadlore.com/journals/JISC

A Systematic Review of Robotic Process Automation in Business Operations: Contemporary Trends and Insights

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Received: 06-20-2023 **Revised:** 08-22-2023 **Accepted:** 09-03-2023

Citation: V. Bhardwaj, "A systematic review of robotic process automation in business operations: Contemporary trends and insights," *J. Intell Syst. Control*, vol. 2, no. 3, pp. 153–169, 2023. https://doi.org/10.56578/jisc020304.

Abstract: Robotic Process Automation (RPA), employing software robots or bots, has emerged as a pivotal technological advancement, automating repetitive, rule-based tasks within business operations. This leads to enhanced operational efficiency and substantial cost reductions. In this systematic review, information was extracted from 62 pertinent research articles on RPA published between 2016 and 2022. The findings elucidate the fundamental principles of RPA, predominant trends, and leading RPA frameworks, alongside their optimal industry applications. Moreover, the necessary procedural steps for RPA implementation in industries are delineated. The objectives of this study encompass highlighting contemporary RPA research directions and evaluating its potential in streamlining diverse business processes.

Keywords: Robotic process automation; Digital transformation; Automation; Business operations; Systematic literature review

1 Introduction

In the contemporary business landscape, RPA has been identified as a pivotal technological advancement. With the digital age imposing challenges such as handling extensive data, catering to growing customer service expectations, and optimizing costs, the role of RPA has grown in significance. Through the automation of repetitive, rule-based tasks, human resources have been liberated to focus on more strategic endeavors, thus enhancing efficiency, curtailing costs, ensuring accuracy, improving compliance, and augmenting customer experiences.

To maintain a competitive edge, it has been observed that organizations intensively focus on refining operational efficiency by managing and redesigning business processes. In achieving this objective, the indispensability of Information Technology (IT) is emphasized. RPA, a technology grounded in the realms of information technology, computer science, electronic and communication engineering, and mechanical engineering, capitalizes on automation, networking, and an integration of hardware and software to facilitate rudimentary tasks. As a rule-governed software-based approach, RPA has been geared towards automating business processes characterized by recurring operations, structured data, and predictable outputs [1, 2]. Recent studies have affirmed that RPA amplifies efficiency, hastens response times, trims costs, and curtails errors, especially in back-office processes that do not directly engage the customer [3, 4].

Applications of RPA have been observed across a multitude of industries and functional domains. In Finance and Accounting, tasks such as invoice processing and reconciliation have been automated. Within the Human Resources sector, processes like employee onboarding and benefits administration have seen automation. Customer Service, Supply Chain Management, and Healthcare have similarly been beneficiaries of RPA applications, where processes ranging from ticket management to patient data entry have been streamlined. Market predictions from the research firm Adroit forecast the expansion of RPA at a compound annual growth rate (CAGR) of 33%, estimating its worth at $6.22 billion by 2025. Such projections underscore the escalating demand for RPA deployment across diverse industries, particularly as businesses grapple with economic challenges.

Furthermore, a significant impetus has been observed towards automating organizational processes. The automation of tasks such as accounts payable has not only augmented the efficiency of business operations but also enhanced their accuracy and security. Challenges, however, have been encountered, particularly when integrating automation software, which demands data collection and input. Certain organizations were found to utilize software incompatible with prevalent data transfer methods, such as SFTP batch input or APIs. Consequently, an inability for systems to interface with requisite applications for data management was noticed. Yet, solutions have emerged: software "robots" capable of bridging this gap. Rather than relying on manual data input into Enterprise Resource Planning (ERP) systems, these bots have been employed for automated data insertion. Such applications of software bots epitomize the essence of RPA, which has been credited for augmenting Return on Investment (ROI) [2, 3]. Evidently, the efficacious implementation of RPA in business processes is paramount.

The ensuing study pursues three primary aims: to delineate the foundational elements of RPA, to elucidate the RPA implementation lifecycle, and to underscore its relevance in real-world contexts.

2 Methodology

This investigation's methodological underpinning is grounded in the principles and procedures elucidated by Ali and Gravino for systematic literature reviews (SLR) [5].

2.1 Research Question (RQ)

Prior to embarking on an SLR, the formulation of precise research questions is recognized as paramount, as evident from the practices of both established and novice researchers. It is understood that these questions profoundly influence subsequent research endeavors as they encapsulate the investigators' objectives and drive the direction of inquiry. In this context, the predominant aim of the present SLR was to discern and analyze extant research articles and projects focused on the domain of RPA. Consequently, the subsequent RQs were identified for this review:

RQ 1: What is understood by RPA and what resources have been identified for its implementation?

RQ 2: In what ways is RPA distinguished from test automation?

RQ 3: What challenges have been observed during the implementation of RPA?

RQ 4: How is the potential of RPA perceived in real-world scenarios concerning the automation of business processes?

2.2 Search Scheme

The research questions dictated the development of a comprehensive search scheme. This scheme was bifurcated into two segments:

- Initial search
- Supplemental search

For the initial search, the subsequent procedures were executed:

(1) A compilation of pertinent keywords related to the subject of the study was created.

(2) Synonyms for these principal terms were also identified.

(3) Boolean operators, namely 'AND' and 'OR', were utilized to refine the search outcomes. The primary search strings were:

- ("RPA")
- ("RPA" OR "Intelligent Process Automation")
- ("RPA") AND ("Intelligent Automation")
- ("RPA" OR "Virtual Workforce" OR "Software Robots" OR "Desktop Automation" OR "Process Intelligence")

The following databases were employed to unearth and select the research articles pertinent to this SLR:

- Google Scholar
- IEEE Xplore
- Springer
- ScienceDirect
- Scopus
- ResearchGate

In the aftermath of the initial search, there was an examination of references within the acquired research papers to identify any potentially overlooked research during the primary search. This stage is known as the supplemental search.

Publications spanning the years 2016 to 2022 were considered for this review. From these designated databases, approximately 92 research papers were identified during the initial phase. The secondary search, guided by references from the preliminary selection, unveiled an additional 20 relevant research articles. Thus, a collective 108 papers emerged from the combined search phases. However, upon application of specific inclusion/exclusion and quality assessment criteria, 62 out of the 108 publications were deemed fit for a systematic analysis. A subsequent section elucidates the criteria adopted for the screening of these papers.

2.3 Study Selection Process

Following the identification of potential research papers based on titles and abstracts, rigorous inclusion/exclusion and quality rating criteria were employed to refine the selection, ensuring the retention of only the most pertinent and credible articles for analysis.

Inclusion Criteria:

• Articles emphasizing RPA specifically within the domain of software automation.

• Studies that not only implemented RPA and intelligent automation across diverse public sectors but also provided insights related to at least one of the predefined research questions.

• Sole emphasis was placed on articles published in academic journals, with those presented solely at conferences being disregarded.

Exclusion Criteria:

• Papers focusing primarily on hardwired robots, despite the overarching theme of robotics and automation, were excluded to maintain the focus on software-driven automation.

• Articles merely employing the term ‘robotics’ without a specific emphasis on RPA were deemed irrelevant.

• Duplicitous articles identified across multiple digital platforms were systematically eliminated.

• Non-peer-reviewed articles and those confined to abstracts were dismissed from the analysis.

For a comprehensive understanding, it is paramount to elucidate why particular criteria were considered pivotal for this research. The emphasis on journal articles, for instance, stems from the recognition of the rigorous peer-review processes these publications typically undergo, enhancing the credibility of the derived findings. Similarly, the specific focus on software-driven automation as opposed to hardware-centric robots ensures that the findings are tailored to the niche area of RPA, rendering the results more applicable to stakeholders in the software automation domain.

2.4 Evaluation Criteria for Research Quality

Subsequent to the delineation of inclusion and exclusion criteria for research articles, a comprehensive set of benchmarks was deployed to ascertain the quality and relevance of the research articles in the SLR. It can be posited that these benchmarks offer an additional layer of scrutiny for the selection of research articles. The quality of the research papers was gauged against an established set of guidelines. The final roster of articles incorporated into the SLR was determined through an evaluation based on eight pertinent questions. Scores were apportioned to each question based on its alignment and depth in addressing the RQs with the ensuing directives:

• Rule 1: Responses fully addressing the RQ were allocated a score of 1.

• Rule 2: Above-average responses to the RQ were granted a score of 0.75.

• Rule 3: Mediocre responses to the RQ merited a score of 0.5.

• Rule 4: Responses deemed below average in addressing the RQ received a score of 0.25.

• Rule 5: Non-responsive answers to the RQ were assigned a score of 0.

The metrics for the quality appraisal were established based on the subsequent questions:

• Q1. Are the objectives of the investigation explicitly articulated?

• Q2. Is the deployment of RPA elucidated adequately?

• Q3. Do the publications cite existing research gaps and challenges?

• Q4. Is the RPA process delineated comprehensively and coherently?

• Q5. Are the requisite resources and tools for RPA distinctly detailed?

• Q6. Are the performance evaluation methodologies employed aptly characterized?

• Q7. Is the research implementation completed?

• Q8. Are recent advances in the research papers considered?

• Q9. Are the constraints and boundaries of the research robustly analyzed?

Each article’s cumulative score was derived by aggregating the scores obtained for each question, using the aforestated quality evaluation guidelines. Articles with an overall score exceeding 5 were incorporated into the SLR, while others were excluded. Following the implementation of the inclusion and exclusion protocols, quality assessment criteria, and the removal of duplicated articles, 62 studies were identified as the most rigorous and germane for the SLR.

2.5 Methodology for Data Extraction

Data essential for addressing the research queries delineated in section 3.1 were culled from the selected 62 research publications. During the extraction phase, it was observed that not every publication offered comprehensive answers to all posited questions. Figure 1 provides a granular analysis, charting the annual distribution of research publications from the span of 2016 to 2022.

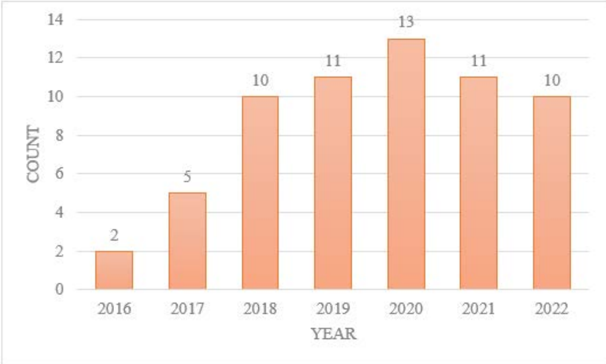

Figure 1. Distribution of publications by year (2016-2022)

3 Background

3.1 Definition and Significance of RPA

The prominence of RPA has been increasingly recognized due to its potential to augment productivity while simultaneously diminishing operational expenditures. This capability, in conjunction with enhancing both customer and employee experiences, affords a more rapid return on investment [6, 7]. Market projections suggest a valuation of $25.56 billion for the RPA sector by 2027, while the AI market is predicted to attain a value of $390.9 billion by 2025. At its core, RPA involves the deployment of software robots, colloquially termed as 'bots', which mimic human operations via a system's user interface. These digital assistants function to alleviate human employees from mundane and repetitive tasks that, albeit uncomplicated, consume significant personnel hours [8, 9].

Contrary to misconceptions, RPA neither pertains to industrial robotic technologies nor manifests as a physical entity. Instead, as illustrated in Figure 2, it is conceptualized as an innovative employment of software, wherein software bots are cultivated and educated to mechanize specific business processes. The primary role of this non-tangible software entity is to undertake process activities, thereby replacing or reducing human intervention within applications. Noteworthy instances of repetitive, rule-based business procedures where RPA exhibits proficiency encompass [10, 11]:

- Engaging with email attachments and links,
- Refining and formatting Excel spreadsheets,
- Navigating across disparate software systems while transcribing data,
- Extracting data from structured documents,
- Executing predefined, on-demand tasks.

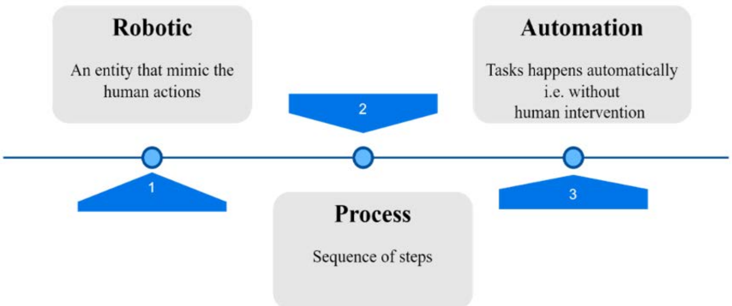

Figure 2. The conceptualization of RPA

The efficacies of RPA solutions are observed to be markedly enhanced when integrated with other avant-garde technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP). The synergy achieved through these integrations operates as follows:

AI: The fusion of RPA and AI paves the way for intelligent automation. AI technologies, encompassing facets like computer vision, natural language comprehension, and cognitive capabilities, when integrated, equip RPA bots to execute tasks necessitating decision-making, data interpretation, and experiential learning. In essence, AI aids in amplifying RPA's scope by granting bots the capability to decipher unstructured data, forecast patterns, and navigate dynamic scenarios.

ML: By amalgamating ML algorithms with RPA, bots can progressively learn from data, adapting to evolving patterns and refining their efficiency over iterations. Tasks spanning pattern recognition, anomaly detection, and predictive analytics can be automated, allowing RPA bots to further hone their intelligence, precision, and efficacy in automating tasks.

NLP: NLP endows RPA bots with the ability to decode and interact in human language, both spoken and written. This synergy enables bots to manage tasks like email processing, chatbot interfacing, voice-command execution, sentiment analysis, and multi-lingual translations. Through NLP, RPA's capacities are expanded to mechanize communication-heavy processes, delivering a more intuitive and organic user interaction experience.

Historically, process automation was restricted and necessitated coding through web scraping tools, Selenium being a noted example. However, the emergent demand for advanced tools and frameworks has driven RPA's evolution, with myriad tools now being proffered by industry titans. While some tools cater to industry-specific needs, others display versatility, catering to a broad spectrum of business process automation requirements.

3.2 Resources for RPA

Figure 3. Most prominent RPA tools

Significant attention has been directed towards various RPA vendors, their products, and subcomponents. Predominantly, the 'big three', as depicted in Figure 3, encompass market leaders such as Blue Prism, arguably the inaugural RPA software, followed by UIPath and Automation Anywhere [1, 12–14]. Other noteworthy products include Workfusion, Kryon Systems, Softomotive, Contextor, EdgeVerve, niCE, and Redwood Software. While many of these serve as standalone RPA tools, some, like Pegasystems and Cognizant, seamlessly integrate RPA within traditional BPM, CRM, and BI functionalities [15]. A comparison between the major RPA vendors, Automation Anywhere, Blue Prism, and UiPath, is detailed below [6].

3.2.1 Automation anywhere

Automation Anywhere has been recognized as a leading global provider of RPA software, delivering cloud-native, web-based, intelligent automation solutions. It is considered instrumental in transforming the operational methodologies of businesses. Notably, its IQ Bot integrates the prowess of RPA with advanced AI technologies such as Computer Vision, ML, fuzzy logic, and NLP. This fusion facilitates the identification, extraction, and validation of unstructured data from business documents and correspondences [16, 17].

• Architecture of Automation Anywhere

Presented in Figure 4, the architecture of Automation Anywhere encompasses three main components:

(1) Bot Creator: This serves as an automation development environment tailored for the creation and customization of automations. Bots are constructed using robotic process tools, and within Automation Anywhere, three distinct bot categories emerge: Task bot, Meta bot, and IQ bot.

(2) Control Room: Centralized management of all facets of automation development and deployment is facilitated through the Control Room, a web-based platform. This interface not only connects to Bot Creators and Bot Runners but also integrates an array of specialized web services.

(3) Bot Runner: Deployed on machines, Bot Runners execute automations. They can be installed on desktops, virtual machines in data centers, or even in cloud environments.

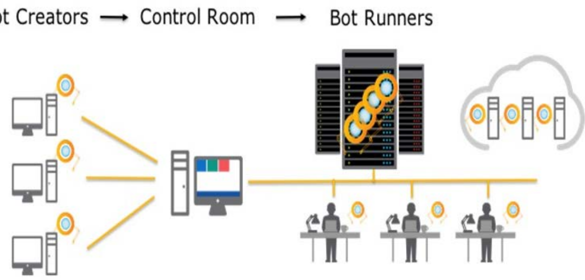

Figure 4. Architecture of automation anywhere

3.2.2 UiPath

UiPath, another distinguished RPA tool, operates primarily as a Windows desktop application. This solution boasts numerous features designed to enhance scalability, mitigate repetitive tasks, and curtail human intervention. It effectively employs a framework, sequence, and flowcharts for its operations [18].

• Architecture of UiPath

UiPath's architecture can be demarcated into three primary product sets:

(1) UiPath Studio: Within this environment, automation workflows are crafted using pre-designed activities. Both rudimentary and intricate tasks can be automated, depending on the client's specifications.

(2) The UiPath Robot: Robots of UiPath execute workflows devised within the Studio. For successful task completion, it is imperative that the robot remains operational.

(3) UiPath Orchestrator: This component is pivotal for publishing projects and executing automation workflows across multiple platforms simultaneously.

3.2.3 Blue Prism

Originating from the UK, Blue Prism is renowned for its contribution to RPA product development. Its tools are designed to automate clerical back-office processes that emulate human interactions. It is widely acknowledged that Blue Prism pioneered the domain of RPA. By automating monotonous, repetitive back-office tasks and elevating accuracy levels, Blue Prism has facilitated businesses in achieving agility and cost-effectiveness. The software offers an intuitive drag-and-drop flowchart for progressive process automation.

Table 1. Comparative analysis of RPA tools

S. No.	Characteristics	Uipath	Automation Anywhere	Blue Prism
1	Architecture	Web based	Client server architecture	Client server architecture
2	Base technology	Microsoft - SharePoint workflows, Kibana, Elasticsearch	Microsoft technology stack	Microsoft C#
3	Process designer	Visual process designer	Script based	Visual process designer
4	Process unstructured data	Medium	Medium	Medium
5	Reusability of code	Yes	Yes	Yes
6	Robots	Front office and back-office robots	Front office and back-office robots	Back-office automation only
7	Recorders (macro readers)	faster process mapping	faster process mapping	Does not support
8	Accessibility	Browser and/or mobile access	App based access only	App based access only
9	Accuracy	High accuracy	Reasonable accuracy	High accuracy
10	Reliability	Moderate	High	Very high
11	Operational scalability	Frequently crashes	Limited to mid-scale environment	Scalable
12	Pricing	Aggressive, attractive entry level pricing	Higher cost of deployment	High cost
13	Certification and education	Free online training and certification	Available	Certification program available

• Architecture of Blue Prism

The architecture of Blue Prism is bifurcated into two main components:

(1) Process Studio: Both a flowchart studio and a hub where business logic, control loops, variables, and object calls converge. It operates mimicking human user actions.

(2) Object Studio: Within Blue Prism, the Object Studio is reserved for the creation of distinct objects, particularly the Visual Business Object (VBO). Actions can be orchestrated within these objects, adding versatility to the architecture.

The optimal selection of an RPA tool is contingent not solely on its popularity but requires a holistic assessment, factoring in the intended location of implementation, budgetary constraints, the existing technological framework, and workforce capabilities. For a comprehensive comparison based on ten standardized attributes, readers are directed to Table 1 [19, 20].

3.3 Advantages of RPA

RPA has garnered significant attention from businesses due to its potential to drive transformative benefits. The potential for increased revenue generation and the augmentation of workforce productivity are noted as prime factors for such interest. Skepticism, however, still prevails among certain business proprietors concerning RPA's implementation. In this section, the various merits of RPA are delineated, as shown in detail in Table 2, to elucidate its appeal to researchers and business entities.

Table 2. Benefits of RPA

S. No.	Benefit	Description
1	Productivity	Bots are designed to emulate tasks a human can perform on a User Interface (UI). When repetitive operations, such as those performed over 200 times, are considered, bots can execute these without any intervals, neither necessitating breaks nor exhibiting fatigue [19, 21–23]. Contrarily, human repetition for such tasks remains unfeasible. Thus, a notable enhancement in overall productivity is observed.
2	Efficiency	RPA software has the capability to operate ceaselessly, maintaining consistent output quality 24/7 [24]. For any exceptions that arise, bots are equipped to manage them, producing comprehensive reports detailing activities and outcomes without delay.
3	Accuracy	Errors in human input are inevitable, compelling double checks, especially for outlier results. In contrast, bots, when programmed correctly and tested rigorously, exhibit minimal errors due to their adherence to a given set of instructions.
4	Security	The present-day emphasis on data protection across industries is paramount. Despite the best intentions, human errors can jeopardize sensitive data. RPA, however, ensures a more secure processing environment, limiting access to sensitive data exclusively to the bot.
5	Scalability	Challenges such as time constraints, multifaceted steps, real-time processing, language barriers, and intricate calculations pose as bottlenecks when humans process data. Bots can be programmed to navigate these challenges, maintaining consistent performance, thereby facilitating seamless scalability in response to varying business demands.
6	Analytics	Manual logging of each task remains not only arduous for humans but also susceptible to errors. In contrast, bots can be designed to provide detailed logs of processes, inclusive of encountered exceptions. Such detailed analytics expose process inefficiencies and offer insights into system trends and client behaviors, paving the way for informed decision-making and system optimization.

3.4 Challenges Associated with RPA Implementation

While the merits of RPA have been elaborated upon in the preceding section, it is imperative to address the inherent challenges associated with its deployment. Despite its potential to enhance productivity, realize cost savings, and elevate client experiences, several obstacles can potentially impede its optimal functioning. Predominant challenges faced by enterprises during RPA implementation are illustrated in Figure 5 [7, 25–27].

To derive a comprehensive understanding of RPA, it is essential to balance its potential advantages against the challenges it presents. The landscape of RPA is evolving, and as it becomes more integrated into various industry sectors, a deeper comprehension of both its strengths and limitations becomes indispensable. By identifying these challenges early on, measures can be devised to mitigate their impact, ensuring that organizations can harness the full potential of RPA while being cognizant of its limitations.

3.5 Distinction Between RPA and Test Automation

While both terms, RPA and Test Automation, encompass the element of "automation" and inherently aim to diminish manual intervention, it is pivotal to delineate the inherent differences between them.

For clarity, definitions of each are presented. RPA is defined as software robots designed to perform tasks traditionally executed by humans. The creation and deployment of these software robots are facilitated by RPA techniques. These robots, using predetermined activities and business rules, can autonomously execute a range

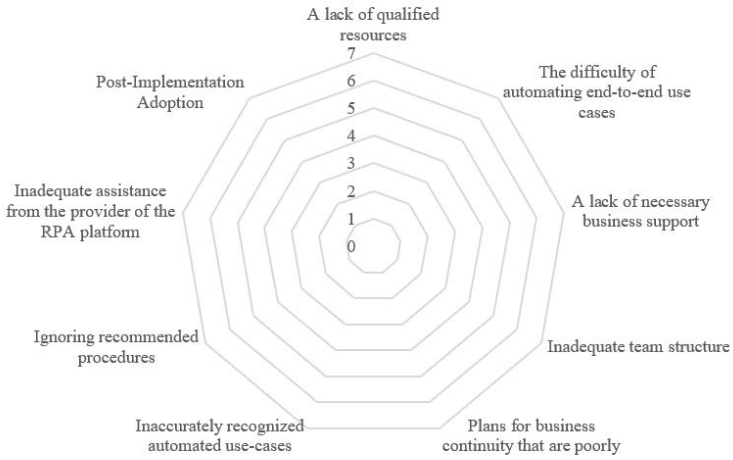

Figure 5. Challenges encountered in RPA implementation

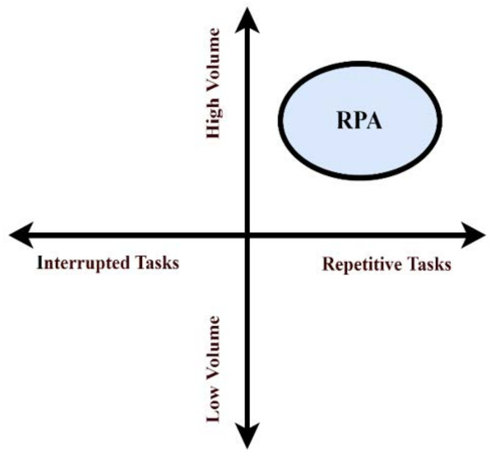

Figure 6. Processes optimally suited for RPA implementation

of tasks, transactions, and processes across multiple software platforms [28–30]. Human intervention is rendered unnecessary for achieving the intended outcome. Notable tools associated with RPA include Automation Anywhere, Blueprism, UiPath, and NICE, among others. Figure 6 illustrates processes apt for RPA implementation.

On the other hand, Test Automation refers to specialized techniques in software testing that utilize tools to govern test execution. The outcomes produced are then juxtaposed with expected results. The bulk of automated testing is conducted with minimal to no involvement from test engineers. It is considered a pivotal stage in the developmental trajectory where supplementary testing, often laborious when performed manually, is introduced. Renowned tools that facilitate test automation encompass Selenium, HP - UFT/QTP, IBM - RFT, Appium, and Jira, among others [11, 25].

It has been observed that RPA and Business Process Management (BPM) are frequently paralleled by analysts, perceived as tools with analogous functionalities. Nevertheless, distinctions between RPA and BPM are palpable [31, 32]. While BPM endeavors to reconfigure processes to augment effectiveness and efficiency, RPA is primarily focused on automating pre-existing processes. This is achieved by modeling the extant process in its authentic form, subsequently executed by a robot.

4 Hierarchical Classification of Bots Within RPA

Within the ambit of RPA, the term "Robot" or "Bot" is often used to refer to a program designed to emulate human-system interactions, albeit devoid of human intervention. A differentiation into three principal categories has been proposed, grounded on the bot's inherent operational and adaptive capabilities. This stratification is instrumental in ascertaining the appropriate bot variant for organizational deployment.

4.1 Programmable Bots

Bots encompassed within this category are typically crafted using specific coding languages or through the utilization of pre-established coding modules. It is imperative for the coder to assimilate the entire operational process, subsequently programming the bot to consistently execute prescribed instructions. Alterations in operational protocols or updates necessitate modifications in the foundational coding.

4.2 Self-Learning Bots

Such bots predominantly engage with structured data, diverging from mere replication of user interface interactions. In the absence of inherent self-learning faculties, these bots would be constrained to a predefined array of arguments and decision-making protocols. However, with the integration of AI and ML algorithms, these bots are endowed with the capability to analyze data and subsequently refine their decision-making processes based on the ingested data.

4.3 Cognitive Bots

Resonating with the characteristics of self-learning bots, cognitive bots are further enhanced with advanced proficiencies, enabling them to engage with unstructured data. They are adept at NLP, image recognition, and leveraging ML algorithms. The continuous refinement of these bots allows them to interpret unstructured data presented in varied formats such as voice, text, graphics, and imagery. Observational studies have indicated that in small to mid-tier organizations, the deployment predominantly involves bots from categories 1 and 2.

5 Recommended Practices in RPA Implementation

The incorporation of RPA within an organizational framework differs significantly from a standard application software deployment [33]. Figure 7 delineates the fundamental steps essential for RPA integration. When implementing systems such as ERP or Customer Relationship Management (CRM), minimal or no customization is typically required, as these software solutions have evolved over time to cater to both standard and exceptional procedures [34–37].

Conversely, RPA bots necessitate bespoke development tailored to specific organizational processes. Although modern RPA tools furnish developers with a component and action-based paradigm, facilitating drag-and-drop functionality and action association, they often lack turnkey solutions for direct process automation. A pervasive deficit of RPA comprehension across organizational hierarchies further compounds the complexities inherent to its successful implementation. Given these nuances, meticulous planning and analysis have been highlighted as prerequisites prior to RPA adoption.

For a streamlined and efficacious RPA integration lifecycle, the following cardinal steps have been identified and are emphasized upon:

Process Identification: Processes that are amenable to RPA automation are earmarked. Routine, rule-governed tasks consuming substantial time and resources are predominantly targeted. Processes are appraised based on parameters such as volume, intricacy, and anticipated Return on Investment (ROI).

RPA Tool Selection: An RPA tool or platform is elected, contingent upon its congruence with organizational requisites, scalability, security measures, and integration proficiencies. Considerations encompass vendor assistance, deployment modalities, developmental capabilities, and user-friendliness.

A bifurcated implementation approach is proposed herein, wherein Phase 1 primarily focuses on the automation of extant processes, whilst Phase 2 delves into subsequent enhancements. It is postulated that Phase 1 addresses immediate goals, whereas Phase 2 contemplates a longer temporal horizon. At the inception of the implementation cycle, it is advocated that a synergistic team of in-house executives and external RPA consultants be constituted.

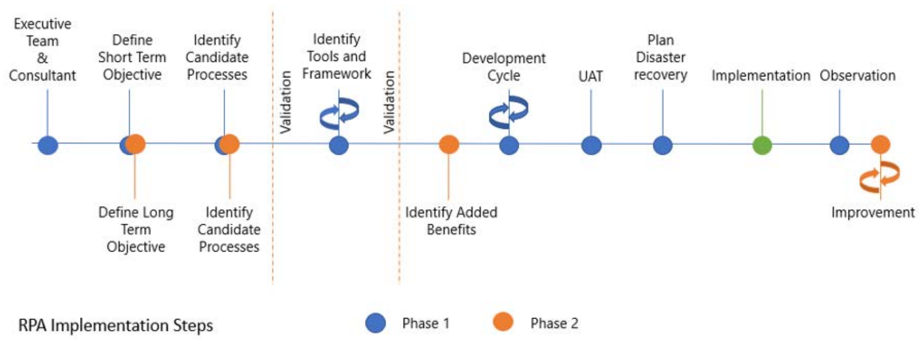

Figure 7. Essential steps for RPA integration

5.1 Assembly of Executive Team and Engagement of Consultants

Initiation necessitates the assemblage of an executive team, knowledgeable in the intricacies of their respective processes, to offer pivotal insights into the anticipated outcomes of the processes slated for automation. Given the constraints of these executive members, who typically offer inputs in user story formats, the engagement of RPA consultants becomes imperative. These consultants, possibly affiliated with third-party vendors or equipped with technical proficiency from within the organization, are tasked with evaluating the viability of the suggested automations, while remaining cognizant of RPA's scope, capabilities, and limitations.

5.2 Demarcation of Short-Term and Long-Term Objectives

Upon the scrutiny of automation potentialities within an organizational structure, it has been observed that executive teams often grapple with the expansive possibilities proffered by RPA. Thus, the explicit definition of short-term objectives is endorsed. These typically encompass automating the existing process with a scope of 20%-30% enhancements, coupled with meticulously documented anticipations. Such a stratagem facilitates outcome evaluation post the automation's realization. Enhancements exceeding the 20%-30% threshold may inadvertently escalate costs due to unforeseen scope modifications. Such a distinction further aids in the formulation of disaster recovery procedures, given that the output of each automated process remains meticulously monitored. Long-term objectives, conversely, emerge as the culmination of an ensemble of short-term goals. Their synthesis offers profound insights, propelling organizations toward extended achievements. Any objectives transcending the immediate scope yet perceived beneficial for the organization are recommended for long-term inclusion.

5.3 Process Nomination for Automation (Short-Term and Long-Term)

Subsequent steps involve the discernment of processes, the automation of which would fulfill short-term aspirations. These might encapsulate procedures such as customer registration, validation, data migration, report generation, and data segmentation predicated on specific algorithms. Short-term nominees often generate data necessitating human intervention, as total reliance on bots is not advocated during the preliminary phase. For long-term dividends, the quintessential processes are those amalgamating multiple workflows to complete a cycle. It is recommended that processes be selected in a manner such that partial completions occur during the first phase, paving the way for integration in the second, ensuring that individual processes undergo rigorous testing during the initial phase.

5.4 Feasibility Validation

Upon identification, the nominated processes aligned with both short- and long-term objectives undergo rigorous scrutiny, assisted by RPA consultants, to ascertain their feasibility. Constraints inherent to RPA may render certain processes unsuitable for automation during either phase or altogether. Consequently, the possibility of modifying the very essence of a process to render it amenable to automation cannot be ruled out. Thus, the incorporation of a validation juncture at this stage emerges as paramount. Such assessments might occasionally necessitate a comprehensive revaluation of nominated processes.

5.5 Tool and Framework Identification and Validation

Following the discernment of candidate processes, technological tools and frameworks required for implementation were evaluated. The guidance of RPA consultants was sought in this endeavor. As highlighted earlier, a diverse range of tools exists, each congruent with specific requirements. It becomes imperative to align tools with corresponding needs. Subsequent to tool selection, validation was conducted. It was during this phase that the return on investment (ROI) was assessed, providing an estimation of the overarching costs. Emphasis was laid on ensuring that automation was achieved within the stipulated budget, with any ambiguities addressed by revisiting the preceding steps.

5.6 Ascertainment of Ancillary Benefits

Post tool finalization, the supplementary advantages proffered by the chosen tool were analyzed. Such benefits encompassed enhancements like increased transparency, notification mechanisms, system integrations, integrated analytics, and data-sharing capabilities with external applications. Although these advantages were thoroughly documented, their incorporation was slated for subsequent phases, post primary implementation.

5.7 Development Cycle Initiation and User Acceptance Testing (UAT)

This stage entailed the selection of a development vendor and the embarkation upon the software development life cycle. The intricacies of this step, being beyond the scope of this section, were not delineated in detail. UAT was introduced when the software solution was deployed in a non-production environment, facilitating internal team testing. Comprehensive insights were gathered prior to granting approval for production deployment.

5.8 Contingency Planning for Disaster Recovery

In anticipation of the imminent RPA solution incorporation, it was deemed essential to have a contingency plan in place. Despite exhaustive testing, practical scenarios might unveil unforeseen exceptions. Hence, well-documented and accessible recovery procedures were established, ensuring prompt rectification in the event of anomalies.

5.9 Actual Implementation

The realization of the solution within the organization marked this phase. Typically executed by the software vendor, it necessitated the sensitization of the internal team and any affected external stakeholders. Training the internal team was integrated into this step, though its extent could dictate it as a standalone preliminary step.

5.10 Observation and Refinement

Post-implementation, the trajectory towards short-term goals was observed. Exceptions, if any, were noted, as were the gains from the new system. Analytical tools were employed to quantify these outcomes and determine deviations from expected results. Given the novelty of the system and the lack of prior practical experience, certain gaps or enhancement requirements were identified. Consequently, a cyclic process of refining the system was initiated, rendering this step iterative and laying the foundation for subsequent phases geared towards long-term goal realization.

6 RPA's Relevance Across Various Domains

In the realm of automation initiatives, the selection of unsuitable RPA use cases has been identified as a principal contributor to failure. Currently, a database of processes deemed ready for RPA is available. Utilizing tried and tested RPA processes is recommended. From the literature, several characteristics of tasks apt for RPA have been deduced [13, 21, 38–43]. A selection of use cases, segmented by business function, is presented in Table 3.

Table 3. Benefits of RPA

Industry	Process	Comments
Banking [39, 44]	Customer service	A notable reduction in the average customer service time is observed. Bots have been found competent in handling tasks ranging from customer onboarding to verification and approval.
Banking	Automation of accounts management	Service enhancement is noted with automated processing, ensuring timely notifications and updates to the end customer.
Banking	KYC and compliance	From card approval to dispatch, processes such as background checks and limit validation are managed by bots in adherence to set business rules..
Banking	Fraud detection	Bots, by implementing fraud detection algorithms across various stages, have achieved results surpassing manual methods.
Customer Care	Data exchange	Customer queries are addressed in real-time, offering precise data with expedited delivery through bot intervention.
Customer Care	Cost reduction	The capability to simultaneously manage multiple processes yields a commendable ROI.
Customer Care	Workflows	Bots efficiently handle pre-defined workflows for various exceptions, ensuring rapid issue resolution.
Insurance	Claims processing	Bots, by adhering to established business rules and workflows, have reduced the validation duration from days to mere hours.
Insurance	Registration	Error-free and efficient customer registration and validation processes have been reported.
Insurance	Risk mitigation	Exception detection and flagging, through stringent validation adherence, are seamlessly managed by bots.
Telecommunications	Productivity and scalability	Bots have been employed to manage large data volumes and automate back-office processes.
Telecommunications	First call resolution	Customer representatives, with bot assistance, have been able to access pertinent customer data and conclude calls without necessitating follow-ups.
Telecommunications	Cost reduction	The capability to simultaneously manage multiple processes yields a commendable ROI.

6.1 RPA Applications in Finance and Accounting

In a study conducted by McKinsey, it was found that 42% of Finance & Accounting (F&A) operations can be fully automated [45–48]. Additionally, another 19% of tasks were identified as being predominantly automatable. Such processes include:

• Invoice processing: Data from scanned documents or digital files can be extracted and processed within ERP systems, resulting in up to an 80% reduction in processing time.

• Payment matching & processing: Payments received via bank lockboxes from various sources are compared to outstanding invoices. Upon processing within the ERP system, remittance receipts are generated.

• Automated journal entries: Emails are processed, compliance checks are conducted, and journal entries are input into ERP systems such as SAP or Oracle, after which notifications to the requester are sent.

• Account reconciliations: Validations are conducted, balancing journal entries are made, and downloads of sub-account balances are automated to rectify discrepancies.

• 3-way matching: The automated matching of invoices with purchase orders (PO) and goods receipt notes (GRN) is facilitated through RPA, ensuring accurate payment and validation of supply chain links.

• Vendor Onboarding: When adding a new vendor to an ERP or invoicing program, the new vendor's details, such as the DUNS number, are sourced online.

• Automate workflow and approvals: Rules-based auto-approval is established in the AP system through RPA. Exceptions are directed to the appropriate authority for manual approvals.

• Financial planning and analysis: Projections based on market and historical data are automated. Pre-populated balances are filled within planning systems, and deviation reports are generated.

• Regulatory reporting: Data collection and cleaning procedures precede the automated generation of regulatory reports.

6.2 RPA Applications in Human Resources

Research by Deloitte indicated that over 50% of standard HR processes have the potential for automation [49–51]. Additionally, 74% of shared service leaders expressed intentions to explore RPA applications. Processes identified include:

• Employee Onboarding: Most onboarding tasks, ranging from documentation receipt to system access provisioning and relevant party notification, are automated [38].

• Employee Offboarding: Processes mirroring onboarding, such as access revocation and standardized paperwork generation, are automated.

• Employee data management: Administration tasks related to current and former employees, contractors, and interns are handled by RPA.

• Recruitment Management: A significant portion of repetitive recruitment tasks, including online candidate searching and incoming resume screening, are undertaken by RPA systems.

• Compensation Management: Employee remuneration data is input into talent management systems.

• Time record validation: Pending timesheets are followed up, time allocations are verified, and anomalies are flagged.

• Earnings and Deductions: Batch creation and importation into payroll systems are facilitated, followed by standard validations.

• Payroll payments: Data is extracted from sources like MS Excel files or emails and input into banking applications by bots [52].

• Automating process hand-offs: Task delegation, which often is inefficient and error-prone, becomes streamlined, integrating both automated and manual HR operations.

• Learning and development administration: Employee certification statuses versus requirements are checked, management is notified, and certification criteria adherence is ensured.

6.3 RPA Applications in Customer Service

RPA applications have been identified as instrumental in automating routine service desk procedures [3, 13, 53]. Processes include:

• Customer Management: Client records are updated or added swiftly by agents, with parallel updates in associated systems.

• Update CRM: Sales and order data transfer from the ERP to the CRM is automated, prompting salesperson notifications.

• Access Management: Identity verification, account unlocking, password resetting, and user data retrieval are facilitated through RPA.

• User Administration: New accounts across multiple systems and programs are established via RPA.

• Incident/Change Management: Incidents and change requests are raised and/or modified by generating tickets, sourcing data from monitoring systems or emails.

• Progress Chasing: Incidents are followed up with users, and ticket status updates are communicated to relevant parties.

• Update or Close Tickets: In the event of incident resolution or lack of response post repeated follow-ups, tickets are closed by RPA.

• External and internal interfaces: Actions in both internal and external systems (like suppliers, partners, or customers) are driven by RPA with non-disruptive integration [43].

6.4 Use Cases of RPA in Information Technology

The potential for RPA applications within IT infrastructure support has been widely recognized. Both unattended and attended automations offer opportunities to streamline manual processes [54–58].

• Database Administration: Routine operations in database administration, such as extending tablespaces, unlocking database locks, and validating databases, have been identified for automation.

• System Administration: Tasks, both scheduled and requiring intervention, utilize management tools for actions such as monitoring backup jobs, performing diagnostics, restarting jobs, or notifying the respective support teams.

• Patch Management: Tools and scripts have been utilized to verify patch levels, schedule, and confirm patching activities.

• Daily Checks: Automation has been proposed for manual application and system inspections, with a notable example being checks in SAP ERP.

• Provisioning: Procedures for provisioning servers, storage, and networks have been systematically carried out.

• Network Support: The domain encompasses the monitoring and management of technologies like LAN, WAN, load balancers, firewalls, and other network configurations [53].

• Automated Testing: The potential for automation in UAT, load testing, and other manual testing using RPA has been studied [59].

• SLA Reporting Automation: SLAs have been computed using data extracted from sources such as router logs, system logs, or ticketing logs.

• Batch Job Monitoring: The automation of batch monitoring, especially for legacy systems like Mainframes and AS400 platforms, is viable. Bots are employed to access the system, extract data from schedulers, and relay the status to the designated distribution list.

6.5 Use Cases of RPA in Sales and Marketing

Research by McKinsey suggests that automation might encompass more than 30% of sales operations. However, the current adoption indicates that merely 25% of organizations have automated even one sales process [60].

• Customer Experience Enhancement: An end-to-end online process for order management, tracking, and inquiries has been devised, aiming for enhanced throughput and customer satisfaction.

• CRM Maintenance: Discrepancies between CRMs such as Salesforce and other platforms like ERP have been rectified. Automated tasks include the registration of new clients, business deals, notifying salespersons, and transmitting sales and order data between ERP and CRM.

• RFP Processing: With the aid of NLP and RPA, RFPs have been swiftly generated. Upon decryption of RFP queries, suitable responses have been compiled into a draft proposal.

• Social Media Monitoring: Sentiments of consumers and enthusiasts on platforms like Twitter, Facebook, and Instagram have been monitored, triggering relevant actions when necessary.

• Competitive Intelligence & Price Monitoring: Competitive product and pricing data have been periodically or as required, extracted from online sources. This near-real-time intelligence informs adaptable product pricing strategies.

• Enhanced Sales Intelligence: Data from various online sources has been consolidated with internal systems like CRM, ensuring the provision of necessary prospecting tools and data to the sales force.

• External Website Updates: Data retrieval and logging into external portals and websites have been automated, ensuring periodic updates to the external sites.

• Automated Rewards Distribution: Based on reward programs, rewards have been dispatched automatically. In addition, gifts have been sent out, and notable dates such as anniversaries have been tracked.

7 Discussion and Conclusions

RPA has been observed to streamline workflows, augmenting the profitability, flexibility, and responsiveness of organizations. The integration of RPA technology into existing business operations and procedures is perceived as a strategy to achieve organizational objectives. Vendors and consultancy firms are often approached by entities seeking understanding in the areas of RPA planning, selection, and deployment. A SLR was undertaken, encompassing seven years of organizational grey literature pertaining to the emergent domain of RPA. In this endeavor, 62 research papers spanning from 2016 to 2022 were scrutinized, guided by five distinct research questions. Data extracted from these studies reveal that Automation Anywhere, UiPath, and Blue Prism are among the RPA tools most frequently adopted for process automation.

Furthermore, the challenges encountered during RPA implementation have been discussed. Delineating between RPA and test automation, distinctions were illuminated, providing a foundation for nascent researchers in discerning the superiority of RPA in process automation over traditional test automation. In this review, varied tools conducive to RPA implementation, the inherent benefits, RPA bot classifications, and steps pivotal to RPA organizational integration were elucidated. A detailed examination was conducted on the applicability of RPA across sectors, including but not limited to Finance and Accounting, Human Resources, Customer Service, Information Technology, and Sales and Marketing.

Consequently, this systematic review aims to furnish insights into RPA for both academia and industries, especially those at the precipice of RPA integration. Gazing into the foreseeable future, RPA's trajectory appears poised towards innovative paradigms, encompassing Hyperautomation, Intelligent Process Automation, Process Discovery and Mining, and Cloud-Based RPA, with a heightened emphasis on Compliance and Security.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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