Integrating Robotic Process Automation with Artificial Intelligence for Business Process Automation: Analysis, Applications, and Limitations

Thomas Kitsantas[1], Peter Georgoulas[2], Evangelos Chytis[1]

[1]Department of Accounting & Finance,School of Economics & Administrative Sciences,University of Ioannina
[2]Accountant and Business Consultant
th.kitsantas@uoi.gr, pgeorgoulas@gmail.com, ehytis@uoi.gr

Abstract. Robotic Process Automation (RPA) integrated with Artificial Intelligence (AI) capabilities can transform business operations through intelligent automation. However, academic research lags behind business applications. Through a systematic literature review, this study analyzes RPA-AI integration for business process automation. 89 articles on RPA and AI applications were analyzed using qualitative methods. The outcomes reveal key application areas including finance, accounting, manufacturing, banking, customer service, healthcare, and human resources. Intelligent RPA-AI integration demonstrated benefits such as improved efficiency, accuracy, scalability, and cost reduction. The analysis also uncovered limitations and risks such as high implementation costs, cognitive constraints, legacy system integration, security vulnerabilities, and lack of technical expertise that should be addressed. This study contributes valuable practical insights for organizations, exploring RPA-AI automation by providing a nuanced analysis of the benefits, while also exposing the current limitations and challenges that must be mitigated. For researchers, the study addresses a clear literature gap with an application-focused analysis to inform future work on intelligent RPA-AI adoption strategies, governance, ethics, and integration with emerging technologies.

Keywords: RPA, AI, Integration, Business Process, Automation.

1. Introduction

In today's competitive world, RPA is gaining popularity in many industries since it can reduce errors, increase efficiency, improve accuracy by automating routine and time-consuming tasks, speed up processes, and free up employees for more complex tasks (Cohen, Rozario, & Zhang, 2019). Unlike other automation technologies, RPA can automate tasks without significant disruption or expense (Asatiani & Penttinen, 2016) due to its non-intrusive nature in current Information Technology (IT) systems. It can be programmed to learn from previous interactions (Willcocks, Lacity, & Craig, 2017), improving performance over time. Thus, RPA is a powerful technology that can assist organizations in achieving greater efficiency, productivity (Radke, Dang, & Tan, 2020), and cost savings by automating repetitive tasks.

A definition for RPA could be the following:

"A preconfigured software instance that uses business rules and predefined activity choreography to complete the autonomous execution of a combination of processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management" (Deloitte, 2017).

Particularly, RPA involves the use of software robots, "bots", or "virtual agents" to automate repetitive and mundane tasks (Lacity & Willcocks, 2016; Rajesh & Ramesh, 2018), such as data entry, form filling, and document processing that humans typically perform. These bots are designed to mimic human actions. They can be programmed to perform a variety of tasks (Willcocks, Lacity, & Craig, 2017), interacting with computer systems, applications, and data sources, including data extraction, data processing, record keeping, report generation, and many other back-office functions (Suri, Elia, & Hillegersberg, 2017). Consequently, monotonous and daily tasks that are usually performed by staff will be replaced by robots and human expertise will be needed at a higher level for decisions requiring judgment.

While RPA is not a new technology, it is still rapidly evolving and growing in popularity as more and more organizations look to leverage its benefits, becoming a very helpful and significant tool in all areas of business management tasks. Organizations with successful implementation of RPA and efficient business processes have seen a favorable impact on their strategic objectives, employee productivity, and customer service (Lacity & Willcocks, 2016). These organizations are able to execute processes cost-efficiently in a short time frame (Lacity & Willcocks, 2016; Schmitz, Dietze, & Czarnecki, 2019), and as a result, have received a lot of media attention (Kregel, Koch, & Plattfaut, 2021). Thus, RPA is of great interest to sectors that traditionally adopt emerging technologies quickly e.g. banks and insurance; (Lacity & Willcocks, 2016), automating existing manual tasks or processes that traditional systems use.

However, in today's challenging environment, business entities are seeking to further maintain competitiveness and efficiency; thus, they are moving towards integrating RPA and AI with Machine Learning (ML) to achieve intelligent automation (Willcocks, Lacity, & Craig, 2017), improving the performance of RPA-AI-driven solutions. Further, incorporating AI with ML and Computer Vision (CV) can enable intelligent robots to learn new processing methods through mathematical analysis, use reasoning, and analyze information, automating human interactions. Therefore, integrating RPA with AI could improve an organization's ability to automate complex business processes involving unstructured data that require cognitive capabilities beyond simple rule-based actions that RPA technology can provide. RPA enabled by AI can become an important factor towards the digitalization of business transformation. Thereby, terms such as "cognitive RPA", "intelligent process automation" and "intelligent automation" generally refer to the same use of analytics and AI techniques.

RPA-AI robots are forecast to grow dramatically in the coming years and are expected to assist in upheaving stagnating human productivity. According to Kommunuri (2022), AI in the context of RPA can be used to automate and speed up the most time-consuming tasks, for instance, accessing data from

the database, validating information, creating relevant documents, and uploading the repository. Likewise, Sestino (2022) suggested that incorporating RPA with AI algorithms could analyze huge quantities of information and data in real-time. As a result, RPA using intelligent robots could automate complex cognitive tasks across various industries, including finance, healthcare, e-commerce, banking, logistics, customer services, and manufacturing.

However, a few researchers have attempted to address AI-driven bots with RPA by examining different RPA software and identifying the limited self-learning capabilities of RPA applications (Agostinelli, Marrella, & Mecella, 2019). Other researchers have engaged intelligent RPA only peripherally as a concept or early indication but have not provided in-depth analyses (Syed, 2020; Van der Aalst, Bichler, & Heinzl, 2018). Additionally, Plattfaut & Borghoff (2022) indicated that there is no such framework regarding the sector of RPA. According to Santos et al. (2019), the field of RPA can be considered unexplored and the use of RPA has only recently begun to grow (Lamberton, Brigo, & Hoy, 2017). Finally, Herm et al. (2020) indicated that "*from a research perspective RPA is poorly understood and only in the early stage of scientific research. Hence, several areas have not yet been sufficiently investigated and pose challenges*".

Conclusively, in addition to the obvious relevance of the AI-RPA technology described in the introduction, this research will build on fundamental pillars of research gaps related to the field of RPA-AI integration in the business domain towards intelligent process automation. The integration of RPA with AI capabilities could be a game-changer for many organizations looking to transform business operations through intelligent automation. However, academic research seems to be stagnating in this area, despite being an important field of development in the industry. To bridge this gap, this study intends to dissect the potential of merging RPA and AI technologies to drive business automation. Thus, the study provides an in-depth analysis by shedding light on the synergies of this integration, exemplifying its applicability across multiple industries, and discussing the benefits and challenges by assessing the risks of this emerging technology.

Particularly, based on the reviewed literature, the current paper will present the applicability and practical use cases of these two combined technologies that could be deployed in several areas, including finance and accounting, manufacturing, banking, and financial services, customer service, healthcare, and human resources and in many other industries. Integrating RPA with AI capabilities could be a key driver of digital transformation, providing intelligent process automation, eliminating repetitive tasks performed by humans, and ultimately contributing to business continuity. In the field of business process management, intelligent process automation strives to improve business workflows, increase productivity, and reduce costs and errors. Therefore, the findings of the study reveal the potential of RPA-AI integration to transform business operations through intelligent automation, while also exposing limitations that should be addressed.

The manuscript complements the present literature in different ways. First, this paper contributes to the current literature by offering a greater understanding of the existing research by justifying and exploring RPA-AI integration. Second, it describes the technical aspects of the implementation and RPA life cycle, indicating that RPA has very limited cognitive capabilities. Third, this research study enriches the existing literature by exploring and further analyzing the business features related to the practical applicability of incorporating RPA-AI, improving business process automation. In addition, this study examines the perceived advantages including the limitations and drawbacks of this emerging technology, complementing the current literature on RPA and AI systems. Hence, the outcome of this study could provide new avenues and insights on RPA-AI applications and limitations to further advance practice and future research.

The remainder of the manuscript is organized as follows: research methodology and materials are presented in the next section, followed by a descriptive literature review of the software robots, including the research gap, the integration of RPA with AI capabilities, the steps, and the tools in

implementing RPA software. The following section analyzes the applicability of RPA within AI technology for automating business processes. The next section analyzes the benefits and advantages of incorporating RPA with AI, followed by the drawbacks and limitations of RPA with AI technology. Finally, a discussion, limitations, future research, and conclusions are presented.

2. Research Methodology and Materials

2.1. Methods

The methods that were applied for this study were based on a scholarly literature review and grounded in theory. An extensive analysis was essential for this research because the main objective of this manuscript was to develop new insights based on comprehensive data collection. Thus, this research paper attempted to investigate the context of the integration of RPA with AI and its applications in automating business processes. Specifically, this study utilizes an exploratory qualitative research methodology (Becker, Bryman, & Ferguson, 2012). Thus, the search strategy was used to identify as much relevant literature as possible using multiple keywords and datasets. The research was conducted using keywords to search for information on the main topic, "Artificial Intelligence, and Robotic Process Automation", by associating it with other interrelated keywords (integration, business process, and intelligent automation). Thus, academic data sources and publications were identified to create the datasets by searching various online bibliographic databases.

2.2. Data Source and Searches

The articles were collected between February and May 2023 and restrictions were applied regarding only the language in English. The search string (keywords) that was applied for limiting irrelevant research was: (("Robotic Process Automation" or "Bots" or "Robots") WITHIN ("Artificial Intelligence" or "AI") AND ("Business Automation)), (("Robotic Process Automation" or "Bots" or "Robots") AND ("Artificial Intelligence" or "AI") FOR ("Business Automation)), (("Robotic Process Automation" or "Bots" or "Robots") WITH ("Artificial Intelligence" or "AI") AND ("Business Automation)).

The data were obtained from several databases which are listed below:

1. Scopus (https://www.scopus.com)
2. Web of Science (https://www.webofscience.com)
3. Business Source Premier (EBSCO) (http://search.ebscohost.com)
4. ABI Inform - Proquest (https://about.proquest.com), and
5. Google Scholar (https://www.google.com)

In the literature review, each article was organized by the authors, using color-coding and tagging techniques (Knafl, 1998). The planning and execution of the study, as well as the screening of results and the structure of its management, was properly organized for this type of approach according to Knafl (1998).

2.3. Study Selection

From the initial pool, peer-reviewed journals and internet sources were considered that directly addressed RPA with AI technology and business automation. The papers were collected following an in-depth review that validated the data collection and datasets through their title, keywords, abstract, submission for review and publication in academic journals, and entries in the databases. A total of 116 prospective journals for the review process were collected related to RPA within AI systems and business automation, excluding publications whose content was not related.

All abstracts and conclusions of the identified 116 papers were carefully read and approved as relevant to the study and organized by the authors, applying techniques such as color coding and tagging (Knafl, 1998). Hence, all of the articles were categorized and organized according to the title and/or theme and compared to what was applicable to each classification. Finally, after several screenings in

the review process, 89 journals that met the relevant criteria were analyzed. The screening criteria and the flowchart of stages involved in the methodology for this study are summarized in Figure 1.
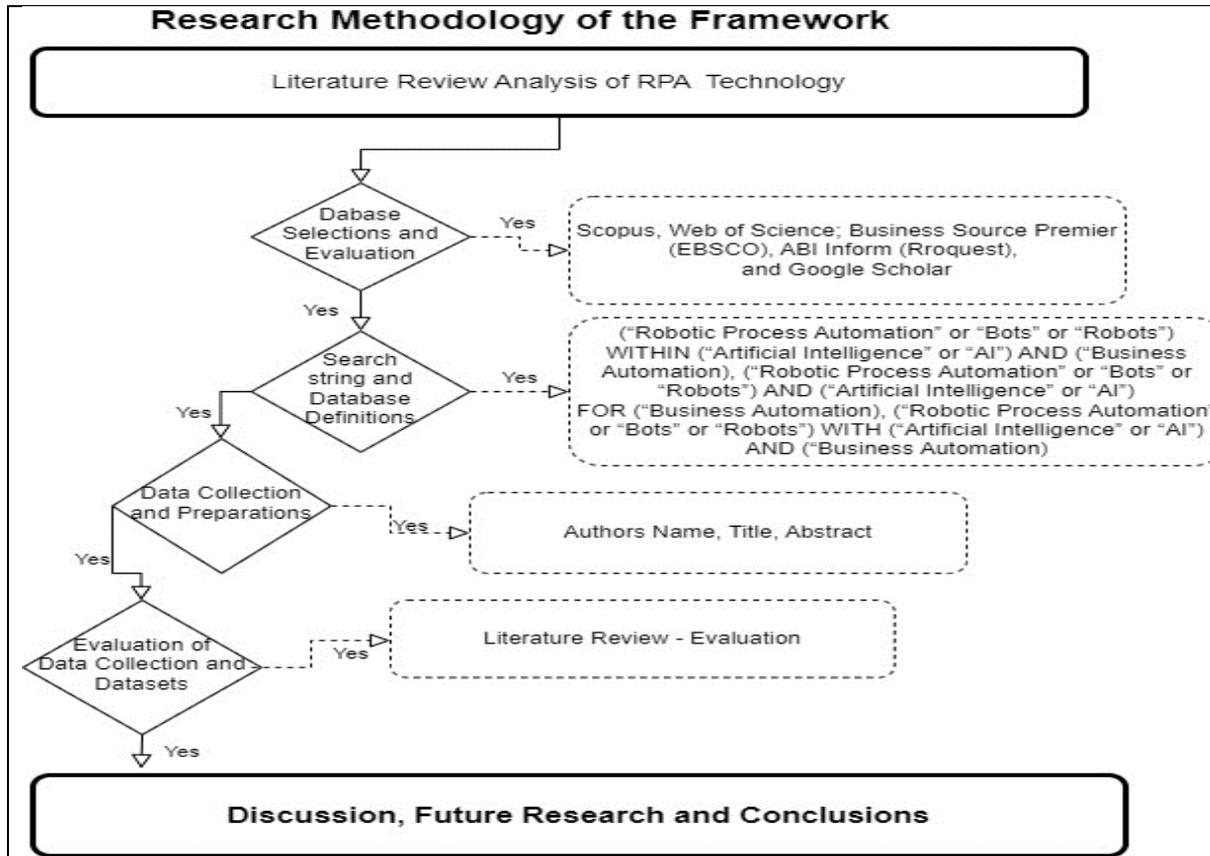

Fig. 1: The flowchart of stages involved in the methodology

3. Literature Review

RPA has gained significant attention as a way to automate repetitive and mundane tasks across various industries and organizations. RPA is a business software solution that performs and automates repetitive tasks using software robots (Kim, 2019; Ribeiro, Lima, Eckhardt, & Paiva, 2021) that are typically replicated by humans. RPA software robots are designed to emulate the actions of an employee (Aguirre & Rodriguez, 2017), interacting with applications, databases, and other systems to perform tasks, (e.g., data entry, data processing, and customer service). They are typically implemented using a graphical user interface (Greyer-Klingeberg, Nakladal, & Baldauf, 2018), which allows users to design and configure automated processes using a drag-and-drop interface. Software robots then execute the processes, also known as bots (Rajesh & Ramesh, 2018), which interact with the target systems in the same way as a human.

Particularly, RPA is defined as the application of specific technology and methodologies based on software and algorithms to automate repetitive human tasks (Gejke, 2018; Mendling, Decker, Hull, Reijers, & Weber, 2018) that are rule-based and time-consuming within processes. RPA can improve significantly the efficiency, accuracy (Ratia, Myllärniemi, & Helander, 2018), and productivity of processes while assisting companies in reorganizing their operations, reducing costs, and improving compliance (Rajesh & Ramesh, 2018). Some common functions that software robots can perform are: searching, opening, reading, editing, updating, validating, importing, and formatting data into other applications. For example, an RPA software robot can access systems in the same way as humans,

through a login, gathering data and processing those, using instructions and rules, and finally uploading these data into a different system. Figure 2 illustrates this process.
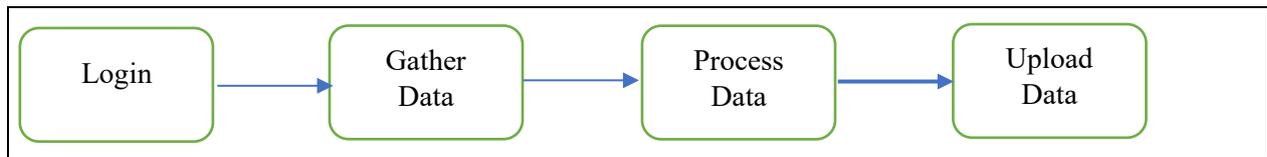
Login		Gather Data		Process Data		Upload Data

Fig. 2: Illustrates a typical RPA Process

According to Gartner, Inc. (2019), RPA software revenue grew 63.1% in 2018 to $846 million, which makes it the fastest-growing segment of the global enterprise software market. Forrester (2017) estimated that by 2021, there could be over 4 million robots automating repeatable tasks, focusing on integration with AI and improvements in RPA analytics. The projected potential economic impact of technologies that will automate knowledge work is estimated to be between $5 and $7 trillion by 2025 (McKinsey, 2019). Likewise, the Grand View Research report indicated that the RPA market will exceed $25 billion by 2027 with a Compound Annual Growth Rate (CAGR) of over 40%. Additionally, RPA technology has been revealed to reduce the cost of human resource-related spending by 20-50 percent with transaction processing costs by 30-60 percent (Syed, 2020).

Consequently, RPAs could be deployed faster than other IT solutions that rely on Application Program Interfaces (APIs) to integrate with systems, often taking two to four weeks as opposed to months or years to implement other systems (Asatiani & Penttinen, 2016). With RPA, business entities can automate processes quickly and easily without requiring extensive IT support, custom coding, or advanced configuration (Asatiani & Penttinen, 2016). This means that businesses can implement digital transformation initiatives quickly and with limited risk, giving them a competitive advantage in the marketplace by changing the way businesses approach digital transformation.

However, Deloitte (2017) has surveyed over 400 companies that have started adopting RPA software, and almost a quarter of those plan to do so within the next two years. They also predict that payback periods are averaging around a year and their expectations of cost reduction, accuracy, flexibility, timeliness, and improved compliance are met or exceeded. Similarly, other studies have suggested that RPA projects and efforts are not always successful (Rutaganda, Bergstrom, Jayashekhar, Jayasinghe, & Ahmed, 2017; Lamberton, Brigo, & Hoy, 2017). Also, human intervention is needed to manually feed the robots with processed data, since robots are not yet skilled in processing or manipulating amorphous data. In addition, robots cannot handle cognitive tasks and rules for which they cannot comprehend, or be modeled, and require the expertise of humans (Perrier, 2018).

Integrating RPA applications with AI capabilities can change the nature of work and further enable to automate business processes. RPA can exploit the potential of AI's capabilities for decision-making in the most diverse areas of reengineering, providing intelligent automation, expanding technological capabilities, technological readiness, and the potential for process automation in several application areas (Ng, Chen, Lee, Jiao, & Yang, 2021). The integration of RPA and AI can be compelling technologies that can lead to significant improvements in business performance and automation (Ribeiro, Lima, Eckhardt, & Paiva, 2021). The combined use of AI capabilities can enable to improve the accuracy and performance of RPA processes in information extraction, identification, classification, prediction, and optimization of processes (Ribeiro, Lima, Eckhardt, & Paiva, 2021). Complex and cognitive processes that previously were performed entirely by human-skilled staff could be increasingly automated by machines (Dias, Pan, & Tim, 2019).

According to Bhave, Teo, & Dalal (2020), AI technology is related among others to ML and Deep Learning (DL) and they can be applied in industries across the globe. AI and ML can allow AI-driven

robots to learn in cooperation with human users or even to recognize and process unstructured data (Hofmann, Samp, & Urbach, 2019), ensuring competitiveness, efficiency, and accomplishing intelligent automation. Integrating RPA with AI technology will enable employees to configure intelligent software robots to collect, extract, learn, and recognize patterns and adapt to new situations or environments (Laurent, Chollet, & Herzberg, 2018), including intelligent Optical Character Recognition (OCR), Big Data (BD), Data Mining (DM), and Analysis Voice Recognition (AVR). Hence, the use of RPA with the complement of AI capabilities and emerging technologies could improve the precision of automated business processes and contribute to better performance, presenting new opportunities to organizations, and accomplishing intelligent automation (Willcocks, Lacity, & Craig, 2017).

Consequently, RPA can automate tasks based on pre-defined instructions as AI could fill the gap by training robots and enabling them to independently identify, analyze, and process several complex tasks, and manage extensive data with cognitive intelligence, allowing them to independent decisions, which are particularly important in organizations and enterprises.

3.1. Research Gap

Given the increasing importance of RPA in the context of AI in the business domain and the lack of research in academia, due to the limited theoretical and practical understanding of the field, this study aims to understand the extent to which AI capabilities and RPA systems can drive to business automation. Thus, this manuscript addresses this gap, building on an extensive literature review, and delving into the intricacies of such integration. In this manner, the study contributes new insights to the literature, by exploring the deployment of AI and RPA technology for business transformation, reshaping operations for enterprises through task automation, accuracy, and cost reduction, allocating human resources to higher-value tasks. Furthermore, the study's findings offer new knowledge on the practical use of cases across diverse industries as well as the potential benefits and challenges that should be addressed. Therefore, the outcomes of this study may provide new pathways for practice on intelligent RPA-AI adoption strategies, governance, ethics, and integration with innovative technologies.

3.2. Steps Involved in Implementing RPA - Life Cycle

Several authors have contributed to developing the idea of an RPA life cycle (Chacón-Montero, Jiménez-Ramírez, & Enríquez, 2019; Yi-Wei, Danping, Shiang-Jiun, Hsiu-Yuan, & Jiann-Liang, 2019), dividing it into the following stages: analysis, design, development, deployment, testing, and monitoring. The RPA life cycle is shown in Figure 3.
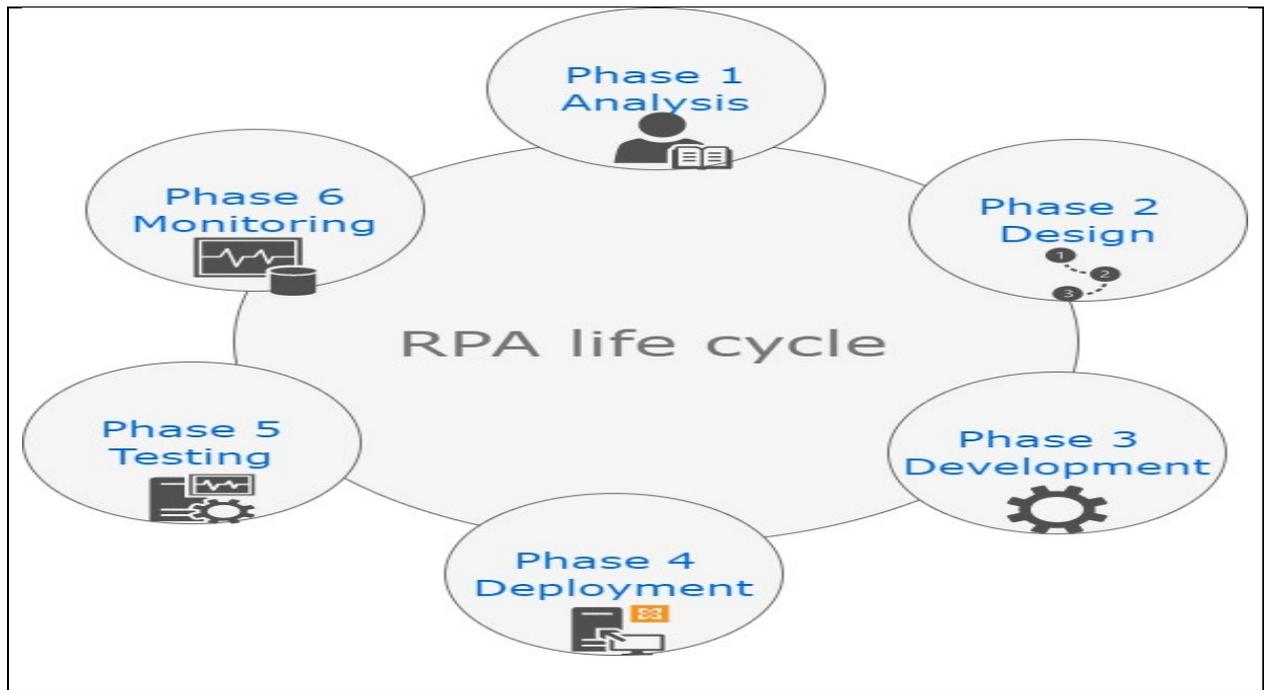
Fig. 3: The RPA life cycle

Yi-Wei et al. (2019) developed a similar model, regarding the phases of the RPA life cycle, such as the RPA Plan, RPA Demand and Definition, RPA Design, RPA Implement, RPA Test, RPA Operation, and RPA Maintenance. However, this research study uses the RPA life cycle from Chacón-Montero, et al. (2019), defining the concepts of RPA life cycle phases, as follows:

Analysis Phase

▪ The first phase is to select and classify the appropriate processes for automation. This involves analyzing the current workflow and identifying repetitive and rule-based tasks that can be performed by software robots. Second, the scope of the automation must be defined, identifying the systems that need to be integrated, and establishing the rules and logic of the actions that can be performed by software robots (Chacón-Montero, Jiménez-Ramírez, & Enríquez, 2019). Third, an RPA tool that meets the defined requirements and characteristics must be chosen. The chosen RPA tool should be easy to use, scalable, and able to integrate with the existing or legacy systems that an organization operates.

Design Phase

▪ The intent of this phase is to describe and analyze in detail all the actions involved in creating workflows, activities, and design patterns, and defining the tasks to be performed in the RPA process (Enriquez, Ramirez, Mayo, & Garcia-Garcia, 2020).

Development, Deploying, and Testing Phase

▪ The RPA solution is then developed and tested in a controlled environment. However, at this point, we have to decide which method should be applied, the classic waterfall model or the agile approach. Yi Wei et al. (2019), suggested a specific solution by comparing the two methods according to their practical use.

Then, the developed flow should be tested according to the requirements, defined in the previous step, followed by testing the solution to ensure that it meets the defined requirements to determine whether it behaves correctly (Chacón-Montero, Jiménez-Ramírez, & Enríquez, 2019). Once the RPA solution has been developed and tested, it is deployed in the production environment. This involves installing the software robots on the machines that will be used for automation and configuring the

solution to run in the background. When the RPA solution has been deployed in production, it is very important to train employees on how to use and operate the new system, ensuring that employees are comfortable working with it.

Monitoring Phase

- ▪ Afterward, the RPA solution has to be monitored and maintained to make sure that it continues to meet the predefined requirements and steps. This involves monitoring the performance of the software robots, identifying and fixing issues that might arise, and making updates and changes to the solution as needed (Chacón-Montero, Jiménez-Ramírez, & Enríquez, 2019). Finally, as the organization gains experience and confidence in the RPA technology, the RPA solution can be scaled up and expanded to automate more processes and achieve greater efficiency in the organization.

Therefore, deploying RPA software in a production environment requires systematic and careful planning, testing, and monitoring to ensure an efficient and successful implementation.

3.3. RPA Tools and Technical Characteristics

The choice of an RPA tool will depend upon the specific needs and requirements of the organization. Thus, it is important to evaluate the features, functionality, and integrations of different RPA tools and utilize the one that best meets the organization's needs. Some of the main RPA tools available in the market that are suitable for different types of tasks and industries are the following:

Table 1.Main RPA Tools

	RPA Software Tools	Description
1.	UiPath RPA Software Tool	UiPath RPA Software Tool offers a wide range of features and integrations. It is suitable for automating an extensive range of tasks across different industries, such as finance, healthcare, and manufacturing.
2.	Automation Anywhere RPA Software Tool	Automation Anywhere RPA Software Tool offers a variety of features and integrations. It is ideal for automating tasks in industries such as banking, insurance, and telecommunications.
3.	Blue Prism is an RPA Software Tool	Blue Prism is an RPA Software Tool that focuses on delivering enterprise-grade automation solutions. It provides automation for complex business processes and is commonly used in industries such as finance and healthcare.
4.	WorkFusion is an RPA Software Tool	WorkFusion is an RPA Software Tool that combines RPA with AI and ML capabilities. It is appropriate for automating complex tasks that require intelligent decision-making and is commonly used in industries, including banking and healthcare.
5.	Kofax is an RPA Software Tool	Kofax is an RPA Software Tool that focuses on automating document-intensive processes. It is useful for automating tasks such as data entry and document processing and is commonly used in industries such as insurance and healthcare.
6.	Power Automate is an RPA Software Tool	Power Automate is an RPA Software Tool that focuses on building activities and processes with no coding experience, and it connects easily with all of Microsoft's services.

4. Potential Applications of RPA with AI Support

RPA and AI are considered two separate domains but are highly complementary. The combination of these two technologies results in intelligent automation that improves business automation. The applicability of these two technologies could be deployed in a diverse range of tasks across numerous fields. The following section presents some of the major practical applications of RPA within AI in different industry sectors. Applications have been categorized into the following groups: Finance and

Accounting, Manufacturing, Banking and Financial Services, Customer Service, Healthcare, and Human Resources.

4.1. Accounting and Finance

RPA with AI capabilities can radically change the accounting and finance fields. According to Cooper et al. (2019), software robots will shift the professional accountant's role to devote and focus more on analytical and strategic work such as financial analysis and forecasting activities (Lavinia-Mihaela, 2019) at the expense of routine activities. The big four major accounting firms (PwC, EY, Deloitte, and KPMG) have already started to automate their work processes, using several digital tools to save manpower and time, improving the efficiency, and quality of audit work.

Combined RPA with AI can be used to automate various modules including accounts payable and accounts receivable, financial reporting, invoice processing, risk management, and financial planning and analysis. Chukwuani & Egiyi (2020) recommended that AI will affect accounting by reducing the risk of fraud, improving the quality of accounting information, and promoting the reform of traditional accounting and auditing. Accounting and finance using software robots could improve payment processing, account reconciliation, clearing customer dues, and report generation (Gotthardt, et al., 2019), improving their overall business; thereby reducing costs and the risk of errors.

Moreover, incorporating RPA with AI algorithms can automate the process of invoicing, including data entry, validation, and approval. Software robots can be trained, using AI capabilities to extract relevant information and validate it against predefined rules, updating the accounting system. In the same way, RPA would automate the process of data extraction from multiple sources, consolidation, and analysis for financial reporting (Tansel, Turkyilmaz, & Birol, 2019). For instance, traditionally, accounting invoice data has to be manually entered into an Enterprise Resource Planning system (ERP), which is time-consuming and error-prone. However, AI-driven bots could automatically validate records into ERP, minimizing human error (Rajesh & Ramesh, 2018), by being programmed to extract data from the invoice, (e.g., vendor name, invoice number, date, and amount), using techniques like OCR to read and interpret the data accurately. Also, AI-powered virtual assistance with Natural Language Processing (NLP) capabilities via natural language queries will allow users to interact directly with the accounting systems.

For instance, Kofax (Kofax., 2020a; Kofax., 2020b; Kofax., 2020c) is a company that develops process automation software for companies and organizations. This tool uses AI that can extract data from documents and other sources (web, e-mail, local files) in various formats and designs, allowing to execution of procedural flows among computer applications in optimizing tasks associated with ERP's information systems.

As a result, AI-driven bots then could validate the data against the company's ERP system, attesting that the information is accurate and complete, saving the accounting employees hours of manual data entry. Further, integrating RPA with AI using Blockchain could automate accounting, ensuring traceable audit trails, automating reconciliations, and authenticating transactions (Kitsantas, Vazakidis, & Chytis, 2019). In addition, software robots within AI via Blockchain can send notifications to the relevant parties – accountants and third parties, including financial transactions, payments, or the procurement staff, alerting them to the status of the invoice, replacing (Kitsantas & Chytis, 2022), in a way, humans and improving performance (Lacurezeanu, Tiron-Tudor, & Bresfelean, 2020), by assisting them to manage other complex processes.

Likewise, General Ledger (GL) can be automated with RPA-AI capabilities by collecting financial data, (e.g., assets, liabilities, expenses, and revenue), and updating the GL with the appropriate data information (Ng & Alarcon, 2021), improving the speed and accuracy of transactions. Consequently, AI-driven robots would significantly reduce the time and effort required to complete the mentioned tasks, improving accuracy and reducing the risk of errors.

In closing, it is worth highlighting that a successful integration of RPA with AI algorithms for

accounting or finance requires a well-defined strategy, an understanding of accounting and finance business processes, and careful consideration of data security issues.

4.2. Top of FormManufacturing

In the manufacturing industry, companies are always looking for ways to optimize their operations and increase efficiency. RPA has emerged as a powerful solution for the manufacturing industry, offering a range of benefits that can assist in improving speed and scalability, increasing productivity (Radke, Dang, & Tan, 2020), and simplifying manufacturing operations. RPA is a technology that can be used to automate various repetitive and rule-based tasks in manufacturing processes, including production order processing, data entry, and invoicing (Lievano, et al., 2022), automating business processes, regarding shipment tracking, payment processing, and quality control (Flechsig, Anslinger, & Lasch, 2021) by performing tasks consistently and without variations, reducing errors (Vasarhelyi & Rozario, 2018).

Logistics could also be automated via RPA with AI capabilities; this includes transport management, monitoring goods in transit, and providing valuable insights regarding carriers and insurance companies. This can be extremely important in industries such as international shipping, aerospace, trucking companies, warehouses, automotive, and medical device manufacturing, where quality is paramount for optimizing their supply chain management and logistics (Sullivan, Simpson, & Li, 2021). Particularly, AI-driven bots could receive purchase orders from any source, including fax, email, or website, and "read" them by extracting data and sending the data to the relevant databases, fulfilling the purchase order. Also, incorporating RPA within AI algorithms can take bills of lading and reconcile them with raw goods inventory, ensuring that all materials have been received and paid accurately, eliminating errors in scheduling, and reducing the risk of delivering the wrong inventory. Additionally, integrating RPA with AI technology might assist manufacturers in identifying trends and patterns in data, which can be used to make decisions about production, pricing, and inventory management, increasing efficiency, reducing costs, and improving accuracy.

According to Li & Yang (2021), a significant deployment in the manufacturing sector is the introduction of Bot-X, using AI core algorithms and virtual assistants in the manufacturing environment. An AI-based virtual assistant is designed to handle complex tasks including order processing, manufacturing processes, and operations in the execution of production tasks. As a result, software robots with AI capabilities could analyze vast amounts of data generated across the manufacturing value chain, generating reports in real time and automating decisions based on predefined rules or cognitive capabilities. Additionally, software robots with AI algorithms and Machine Vision (MV) systems could deliver manufacturers with real-time visibility into their production processes, allowing them to identify issues and bottlenecks immediately, trigger alerts and red flags, adjust production lines, and initiate corrections actions (Shidaganti, Karthik, & Anvith, 2023).

Hence, RPA would enable manufacturers to focus on more strategic and value-added activities (Remko, Larsen, & Lacity, 2022), including innovation and product development, optimizing their processes, improving overall productivity, and overcoming the competition in an increasingly demanding market.

4.3. Banking and Financial Services

In today's world, the banking and financial services industry is highly competitive, with organizations always looking for ways to improve their business automation, increase operational efficiency, and reduce costs. The banking industry is constantly challenged with the processing of vast amounts of sensitive data, which requires high levels of accuracy, speed, and protection. RPA is an effective solution that can help banks automate various processes, changing the business and customer service model and internal operating procedures (Met, Kabukçu, Uzunogullar, Soyalp, & Dakdevir, 2020), allowing banks and financial services companies to automate repetitive and rule-based tasks, for

example, data entry, document processing, and customer service inquiries. Thus, several leading banks have taken steps toward adopting RPA in their organizations (Vishnu, Agochiya, & Palkar, 2017).

However, in the near future, it will be a necessity to further automate business processes, including existing or new accounts and loans, in order for financial institutions to reduce costs. For instance, software robots with AI capabilities and Cognitive Robotic Process Automation (CRPA) could pinpoint the accounts that have been temporarily blocked, and obtain their previous activities, removing any temporary blocks and restrictions. AI-driven bots could open new accounts, by extracting customer data from various sources, such as ID cards or application forms, and validating these data against regulatory obligations. CRPA can metamorphose the banking sector, making core financial functions more efficient while improving safety and security (Villar & Khan, 2021), transforming the existing customer service model and internal operating methods in the financial industry (Met, Kabukçu, Uzunoğulları, Soyalp, & Dakdevir, 2020). Figure 4 illustrates the process of opening new accounts and loan origination. Accordingly, AI-driven bots could extract relevant data from paper applications and documents, calculate key metrics (e.g., credit risk scores and debt-to-income ratios), automating the process of new loan applications. This can significantly reduce the time and resources required to open new accounts and loans, improving accuracy and reducing errors.
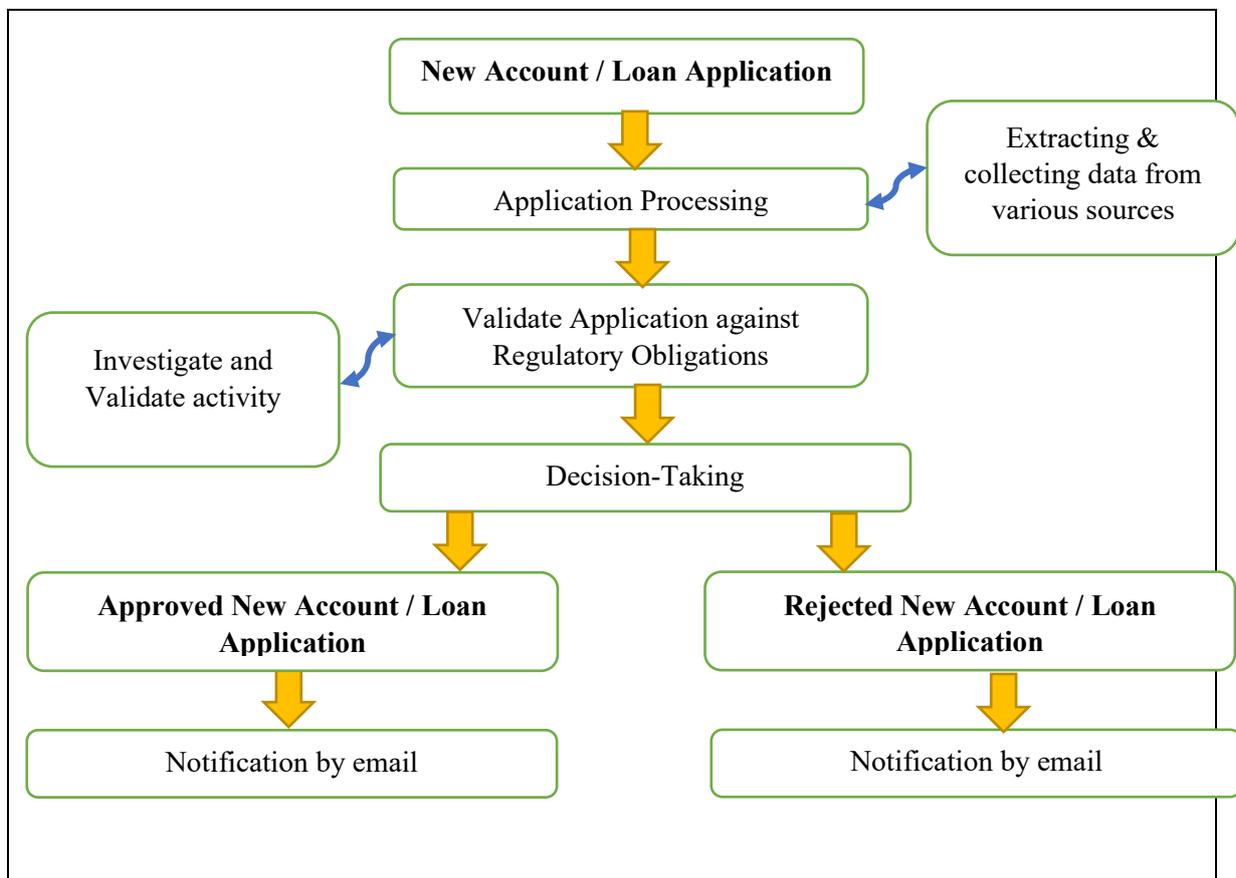

Fig. 4: Illustrates the stages of opening new accounts and loan origination

Moreover, integrating RPA-AI algorithms could automate the process of invoicing and billing, extracting relevant data from invoices, validating them against contracts or orders, and generating payment instructions. Thus, intelligent trained bots could identify patterns, anomalies, and inconsistencies, triggering alerts to human analysts to further investigate suspicious activity. In the same way, account reconciliation could be improved with RPA robots using AI capabilities by automating the reconciliation process, matching transactions across multiple bank accounts or systems, identifying errors and discrepancies, and resolving them automatically. Similarly, credit card issuance can be

automated with AI robots by reducing time-consuming processes, including document collection, credit checks, and determining whether a client is eligible or not for a credit card.

Likewise, fraud detection and prevention could be used with intelligent software robots to analyze large datasets and identify potential fraudulent activities (Maček, Murg, & Veingerl, 2020). Intelligent RPA can also detect anomalies, focus on high-value transactions in vulnerable segments, and send alerts to financial institutions. Further, RPA can be used for generating reports functions (Suri, Elia, & Hillegersberg, 2017) by collecting information from various sources, validating, and organizing data in the required format with high accuracy, managing critical problems with extreme reliability, and sharing reports with the necessary stakeholders. As a consequence, Williams, & Allen (2017), indicated that the operational costs of transactional activities within shared services with the use of RPA and AI technologies can be decreased by up to 30% and even 50%.

Therefore, by reengineering and automating these business processes, banks and financial services companies can significantly reduce the time and resources required to process new applications and loans, automate invoicing and billing, and prevent fraud while improving accuracy, reducing errors, and freeing up employees to focus on more complex tasks that require human expertise (Remko, Larsen, & Lacity, 2022).

4.4. Customer Service

RPA could be a valuable tool for improving customer service, by automating tasks, including ticket routing, data entry, email response, and routine tasks. Incorporating RPA-AI capabilities could also automate repetitive tasks including order processing, and customer inquiries, enabling faster response times, reducing errors, and improving overall customer experience (Goyal & Singh, 2021).

Forbes predicts that by 2025, 95% of customer/firm interactions will be conducted using computerized technologies, with no human intervention (Morgan, 2018). Integrating RPA with AI could effectively handle customer inquiries and services (Wang, Zhang, Zhang, Wenjuan, & Yang, 2021) by answering frequently asked questions, guiding the customer through self-service options, or directing the query to the appropriate representative. Email management with intelligent software robots could be also automated by processing incoming customer emails, reading and analyzing the content of each email, categorizing it based on the customer's needs, prioritizing urgent cases, generating responses, forwarding the email to the appropriate human representative and spam filtering (Khare, Singh, Mishra, Prakash, & Dixit, 2022). Figure 5 illustrates the integration of RPA and AI in customer service.
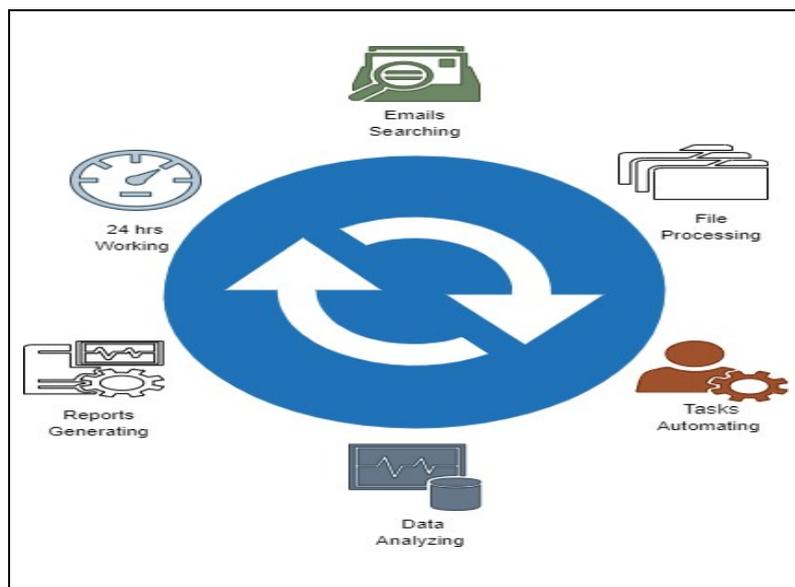
Fig. 5: Illustrates the integration of RPA and AI in customer service

Data management through an intelligent RPA robot could be used to automatically collect, aggregate, and analyze customer data, (e.g., customer reviews and feedback), assisting when identifying areas for improvement and bringing to light potential problems that may require attention. Similarly, order processing could be improved with AI and RPA robots, automating the processing of orders from customers, including invoicing and payment processing, as well as updating stock and inventory, and managing shipping, returns, and backorders (Ng & Alarcon, 2021). Hence, by automating these business tasks, customer service representatives can focus on more complex issues that require human intervention, resulting in faster resolution times and leading to higher customer satisfaction, automating tedious activities (Hollebeek, Rajendra, & Chen, 2019).

4.5. Healthcare

In the healthcare industry, RPA technology has the potential to automate repetitive and mundane tasks (Aguirre & Rodriguez, 2017), and ultimately improve the efficiency of the healthcare system. RPA could be used to automate tasks (e.g., patient registration, claims processing, and appointment scheduling), reducing errors, and improving efficiency, allowing healthcare professionals to focus on patient care (Ratia, Myllärniemi, & Helander, 2018).

For instance, due to the rapid spread of COVID-19, examination rooms were experiencing high demand, resulting in long lines of patients waiting for examinations. AI algorithms with RPA robots could provide a solution by speeding up the testing process for COVID-19, using intelligent robots to collect patient data, integrate them into the Electronic Medical Records (EMR) of the hospital, record the test results, and send these data to different departments while eliminating the manual errors and reducing waiting time (D.G.S. Inc., 2021).

Particularly, intelligent software robots could automate patient data, by enabling faster appointment booking, searching application records and collecting data, validating records such as order processing and integrating to EMR, improving payment processing or prescription management, reducing errors, and improving patient safety. Figure 6 illustrates the application of RPA with AI stages in healthcare. In terms of medical billing, the intelligent software could automate the process, including claim submission and payment posting, enabling a faster payment process.
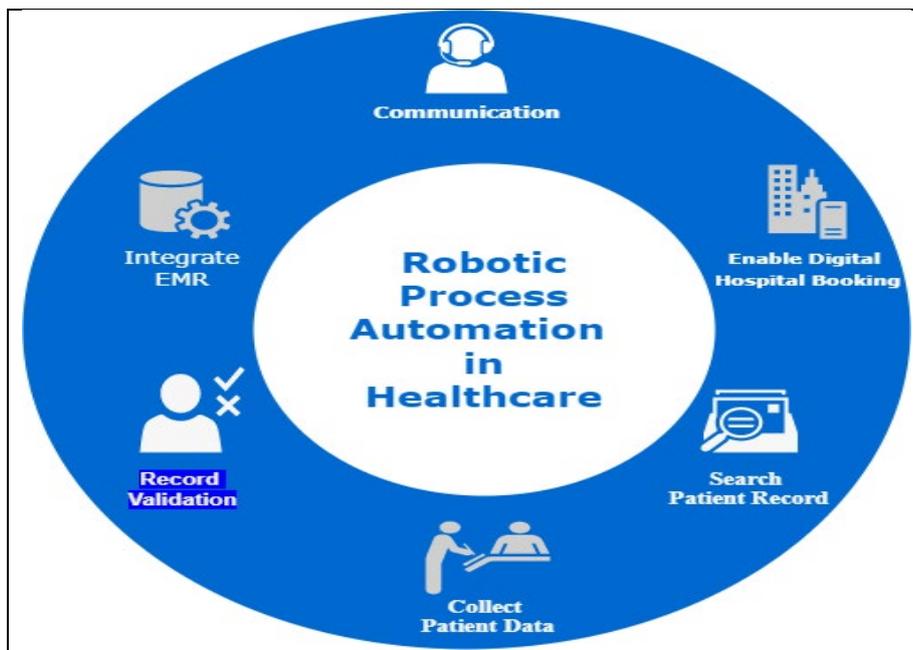

Fig. 6: Illustrates the application of RPA with AI stages in healthcare

Moreover, healthcare organizations deal with a large number of insurance claims on a daily basis which they have to manually process. These claims are time-consuming and liable to errors. By implementing RPA technology with AI capabilities in the healthcare context, organizations could automate claim data entry and validation, verify data accuracy and completeness, and process claims with minimal human intervention. This could save valuable time and resources, reduce errors, and streamline claims processing workflow. For instance, IBM has invested more than 1 billion in AI technology through the Watson Group for medical recommendations. Therefore, intelligent software robots would significantly improve the efficiency, accuracy, and speed of various healthcare processes, allowing healthcare providers to focus on providing better patient care.

4.6. Human Resources

Human Resources (HR) departments are responsible for managing several tasks from recruitment and onboarding to employee data and performance management. These tasks are time-consuming and repetitive (Mohamed, Mahmoud, Mahdi, & Mostafa, 2022), and RPA could be of great assistance (Anagnoste, 2018). Integrating software robots with AI algorithms can automate further HR functions, including payroll processing, performance management, employee data management, and employee engagement surveys.

Subsequently, RPA within AI could automate the process of screening and assessment of curriculum vitae (CVs) matching candidate profiles with job requirements, scheduling interviews, and sending notifications by email to candidates. Intelligent RPA applications might automate the business process of collecting, executing tasks, verifying, and validating employee records in the database. Also, incorporating RPA with AI capabilities could automate the payroll process by automatically extracting employee attendance and leave data, calculating wages, and generating pay slips, as well as automating the process of collecting and organizing employee performance data, creating performance reports, and setting up performance improvement plans. This could significantly reduce the time and effort required to process payroll, while also improving accuracy and reducing errors. For instance, Automation Anywhere (Anywhere, 2020a; Anywhere, 2020b; Anywhere, 2020c) is an RPA tool that supports several areas of applicability, including HR, Customer Relationship Management (CRM), and Supply Chain Management (SCM). It incorporates a module called cognitive automation and analytical data analysis, by providing information on the applicability of AI techniques/algorithms, that can be integrated with ERPs modules.

Mohamed et al. (2022) designed and deployed a Human Resource Management System (HRMS) model based on RPA tools. It was based on a previous case study by Kyheröinen (2018). They focused on developing an application for gathering and storing employees' information from different modules to an HRMS database. The authors found out that intelligent robots reduced time from 8 min performed by a human to 50 seconds performed by a software robot without any intervention needed, working automatically 24 hours per day. Also, software robots completed all tasks accurately and consistently with no errors compared to humans who were more prone to errors, especially when the flow of data was in high demand.

Therefore, RPA with AI could be an essential tool for HR departments looking to improve their efficiency, reduce manual effort, and increase accuracy, automating repetitive tasks, allowing HR staff to focus on more strategic tasks, such as employee engagement, talent development, and organizational culture. The following table summarizes the previous research regarding the main potential applications of RPA-AI capabilities:

Table 2.Main Potential Applications – Benefits and Tasks of RPA-AI Capabilities

	Applications of RPA-AI Capabilities	Benefits and Tasks of RPA-AI Integration
1.	Accounting and Finance	Automate repetitive and mundane tasks, in the areas of account payables and account receivables, financial reporting, invoice processing, risk management, and financial planning and analysis, including data entry, processing, validating and updating, improving the speed and accuracy of transactions, reducing the risk of fraud and errors and generating reports.
2.	Manufacturing	Automate rule-based tasks, such as data entry, production order, processing data, invoicing, shipment, tracking goods in transit, payment processing, and quality control, improving accuracy, increasing efficiency, generating reports in real-time, and automating decisions, based on cognitive capabilities and reducing costs, and errors.
3.	Banking and Financial Services	Automate repetitive and rule-based tasks, including the process of applications and loans, calculate key metrics, invoice processing, and bills of lading, improving business automation, increasing operational efficiency, preventing fraud, reducing time, and costs.
4.	Customer Service	Automate repetitive tasks (data entry, order processing, customer inquiries, and customer service), allowing faster response times, reducing errors, and improving overall customer, and routine tasks.
5.	Healthcare	Automate repetitive and mundane tasks (patient registration, claims processing, and appointment scheduling), improve patient data, validate records, improve efficiency, and speed up several healthcare processes.
6.	Human Resources	Automate tasks, including payroll processing, performance management, employee data management, and employee engagement surveys, improving accuracy and efficiency, automating repetitive tasks, reducing errors and manual effort.

5. Benefits and Advantages of RPA within AI Capabilities

RPA robots with AI capabilities can offer numerous benefits and advantages for businesses and organizations looking to streamline their operations, improve efficiency, and reduce costs. Particularly, some of the main advantages of RPA-AI are the following:

5.1. Improved Efficiency

RPA is a powerful software that can assist businesses in improving efficiency by automating repetitive and time-consuming tasks (Ratia, Myllärniemi, & Helander, 2018). Software robots could work around the clock, 24 hours a day (Driscoll, 2018), which means that processes can be completed at any time of day without requiring human intervention. This could help streamline workflows and eliminate bottlenecks, speeding up overall productivity (Kedziora, Leivonen, Piotrowicz, & Öörni, 2021), helping businesses to reduce human errors (Vasarhelyi & Rozario, 2018), which could lead to costly mistakes and rework, and resulting in significant improvements in efficiency.

However, the use of RPA tools and AI algorithms could enable the ability to complete complex and cognitive tasks at a faster rate than humans, increasing productivity and effectiveness for companies. Intelligent RPA tools could also significantly reduce the amount of time and resources needed to accomplish various business processes, enabling employees to focus on more strategic tasks (Santos, Pereira, & Vasconcelos, 2019), requiring critical thinking and decision-making skills, improving overall performance and functionality.

Therefore, integrating software robots with AI capabilities could ensure that data is accurate and up-to-date, assist companies in improving customer service, automate tasks (e.g., processing orders, and improving response times), and reduce the workload on customer service representatives. This could improve a business's overall productivity, provide a better customer experience, and reduce the time and cost required to ensure compliance (Kedziora, Leivonen, Piotrowicz, & Öörni, 2021).

5.2. Scalability

Scalability is a key factor for businesses that want to grow and expand their operations. As a consequence, software robots can be scaled up or down (Chugh, Macht, & Hossain, 2022) depending on the needs of the business entity to quickly adapt to changing workloads (Santos, Pereira, & Vasconcelos, 2019). This makes it easy to adjust the level of automation based on demand, leading to greater flexibility and agility, ensuring that they have the resources needed to meet the demand.

However, using RPA with AI would be an even more cost-effective way to scale up business operations, by automating repetitive tasks and, reducing the need for human labor, without incurring significant additional labor costs. AI-driven bots can be configured and customized to meet the specific needs of a business in a way that is tailored to their unique requirements, without the need for extensive training or development of complex applications, and automating capabilities - in a matter of weeks, rather than months or years, using other applications.

5.3. Improved Accuracy

Intelligent software robots can perform tasks with a high degree of accuracy and consistency, reducing errors and improving data quality, since they can be programmed to execute tasks with precision and accuracy, leading to better business outcomes. They can perform tasks consistently, without the variability that can occur with human operators, allowing tasks to be performed according to the same set of rules, leading to greater accuracy and standardization (Greyer-Klingeberg, Nakladal, & Baldauf, 2018).

Particularly, intelligent software robots can perform tasks without the need for manual intervention, reducing the risk of errors caused by human operators, and minimizing the time and effort required to perform tasks, leading to increased efficiency and accuracy (Cutura, 2019). Intelligent software robots could be programmed to monitor processes in real-time, identifying and flagging any errors, and resolving them quickly, leading to improved accuracy and reducing downtime. Additionally, RPA with AI could improve accuracy, and increase the speed of tasks, especially when tasks are time-sensitive or require a high degree of precision or intelligent thinking.

5.4. Cost Savings

RPA could significantly reduce the cost of labor by automating repetitive and routine tasks, reducing the need for human labor (Ratia, Myllärniemi, & Helander, 2018), and improving overall productivity, as software robots can be dedicated to tasks, including data entry, invoice processing, and customer service, reducing the time and cost required to complete them (Alt, 2018).

However, the integration of RPA robots with AI capabilities can lead to critical thinking and decision-making, and as a result increase efficiency by completing tasks at a faster rate than humans, improving accuracy, reducing error rates, and achieving high levels of performance. Also, RPA within AI algorithms can improve businesses' compliance regarding regulatory requirements, since they can be programmed to comply with regulations tasks, reducing the risk of non-compliance and associated fines or penalties. Additionally, intelligent bots can help companies achieve availability, reducing the need for overtime pay or the cost of hiring additional employees for overtime work hours since they can work around the clock, saving money and increasing productivity.

6. Challenges and Limitations of RPA with AI Systems

Integrating software robots with AI capabilities could lead to several benefits for businesses, however, it is very important to carefully evaluate and assess some of the potential challenges and limitations of RPA within AI, ensuring that it is the right solution for the business needs. According to Ravn et al. (2016) and Kenneth, et al. (2019), about 30-50% of all RPA deployments fail because of misapplication. Hence, software robots might not be suitable for all tasks that a company uses, meaning we have to

consider and address other issues and problems as well. As a result, some potential limitations and drawbacks that need to be addressed and considered are the following:

1. Integrating RPA with AI can offer great cost savings in the long term, nevertheless, the initial cost of implementing both systems might be high (Sobczak, 2019; Siderska, 2021). High acquisition costs might be associated with licensing, implementation (Flechsig, Anslinger, & Lasch, 2022), customization, and training. Integration and scalability of RPA with AI algorithms installation, error handling, and programming architecture. RPA is also considered less robust than others embedded into core systems (Grung-Olsen, 2017). Thus, it is important to carefully examine and evaluate the potential costs and benefits of RPA adoption (Yatskiv & Vasylyk, 2020).

2. Software robots are designed to perform repetitive tasks based on pre-defined rules and instructions. However, they lack cognitive abilities (Perrier, 2018), and cannot perform tasks that require complex reasoning and decision-making. Integrating RPA with AI introduces new horizons, as well as complexities, requiring high-quality data for intellectual thinking. Hence, inconsistent and inadequate data quality can influence the performance and reliability of the integrated systems.

3. Incorporating RPA with AI requires expertise in diverse technologies, programming languages, and platforms to ensure careful planning (Prasad, 2022) and coordination for the successful integration of both technologies.

4. The use of AI in software robots might have limited integration capabilities with legacy systems or other software applications that are not designed for automation, limiting the range of tasks that can be automated through RPA with AI systems.

5. Integrating RPA with AI algorithms needs additional training and computational resources, which can lead to redesigning tasks and time-consuming (Dey & Das, 2019), processes.

6. Intelligent software robots can pose security risk issues, if not implemented appropriately. They may have access to sensitive data and can be vulnerable to cyber threats or hacking attempts (Herm, Janiesch, Reijers, & Seubert, 2021). Thus, it is very important to ensure that RPA within AI is implemented securely.

7. Software robots within AI algorithms require regular maintenance if any system/application interface changes in order to work properly. This can be time-consuming and costly for companies to maintain both systems effectively, ensuring that all necessary resources are available (Axmann & Harmoko, 2020).

8. Combining RPA with AI can lead to the displacement of human employees or change the existing roles of who were previously responsible for performing all these automated tasks (Suri, Elia, & Hillegersberg, 2017). This might lead to negative consequences for employee morale and potentially create a skills gap in the workforce or may have a negative impact on the workplace (Asatiani & Penttinen, 2016). Thus, it is very important to provide proper training for employees and elaborate on the benefits of this integrated system.

7. Conclusion and Further Research

The scope of this paper was to conduct a review of research related to intelligent automation in integrating RPA-AI to transform business operations and identifying the major areas of applications. We searched potentially relevant studies in 116 leading journals to clarify what is the innovation of intelligent automation for RPA-AI to promote business automation. The selection process led to the identification of 89 articles that offered an overview of this topic. From a theoretical perspective, based on the literature review, this study indicates that the field of RPA and AI technology regarding business automation is still relatively new and that no theoretical frameworks have been formulated. Therefore, first, this manuscript contributes to the current literature by analyzing the technical and business aspects. Second, this research explores the practical implications of RPA within AI capabilities, including finance, accounting, manufacturing, banking, customer service, healthcare, and human resources. Third, the study exposes the advantages as well as the drawbacks and limitations, bringing new perspectives

on how the implementation of RPA-AI technologies can affect business operations. Finally, it provides new knowledge for practice, improving our conceptual understanding, and assisting researchers in further exploring the integration of RPA with AI systems to drive business automation.

The outcomes reveal the potential of RPA-AI integration in transforming business tasks through automation. Combining RPA with AI technology can be a powerful tool that can be used to automate not only repetitive and rule-based tasks; but cognitive processes that require critical thinking which can significantly reduce the time and human effort required. However, integrating RPA with AI has some potential challenges and limitations that need to be properly understood, monitored, controlled, and addressed. They demand a high level of expertise in different technologies, including in programming languages and platforms, in order to ensure safe customization and coordination of them. Integrating AI into RPA requires a high degree of accuracy regarding the input of high-quality data, and any errors in the quality of data can lead to significant problems. RPA with AI software needs regular maintenance to ensure that they are accomplishing tasks properly and with accuracy. Intelligent software robots usually have access to sensitive data and might be exposed to hacking attempts, losing valuable data, if not set properly. In addition, RPA with AI can lead to the replacement of human workers or the modification of existing roles, which previously were responsible for performing all these automated tasks.

On the other hand, RPA with AI capabilities has the potential to revolutionize and digitize the way businesses operate, improving efficiency, reducing costs, and enhancing customer service. Incorporating RPA with AI could automate a wide range of business processes (e.g., data entry, invoice processing, customer support, and many other tasks and procedures), across different applications, systems, and industries. Moreover, as technology continues to evolve, we can expect to see even greater applications of RPA and AI capabilities, especially in industries such as finance and accounting, bank services, healthcare, human resources, and manufacturing.

RPA software in the near future could also be integrated with other technologies in Industry 4.0 technologies. Intelligent Process Automation (IPA), and blockchain technologies can greatly improve the capabilities of RPA-AI to handle more complex and cognitive tasks and make more intelligent decisions based on data analysis. For instance, IPA technologies could greatly help RPA applications to learn from data-driven processes and make intelligent decisions, instead of mapping rule-based processes. Intelligent Document Processing (IDP) with RPA and AI could automate the extraction and processing of data from diverse types of documents, including invoices, contracts, and forms. Natural Language Processing (NLP) is a component of deep learning that is used for speech recognition. It could promote software robots to interact with humans in a more natural and intuitive way. AI-based RPA systems on Big Data platforms can automate processes, and enhance decision-making capabilities for businesses and organizations. Furthermore, secure RPA-as-a-Service can enable businesses to access RPA capabilities without having to invest in expensive infrastructure and training. Cloud-based RPA, robotic devices, and the Internet of Things are growing as they offer greater scalability, flexibility, and cost-effectiveness, creating more automated and efficient processes compared to traditional on-premises solutions. Another unexplored area that RPA and AI will move toward is the era of hyperautomation. A business-driven disciplined approach for organizations to improve and automate IT. In the future, organizations and companies that will adopt hyperautomation will aim to streamline and automate all processes across their business using AI, including ML and RPA as well as other tools and platforms to run everything without human intervention.

Therefore, further investigation is needed to examine and comprehend more intensively the integration of Industry 4.0 with RPA software robots. RPA within Industry 4.0 technologies has the potential to convey significant benefits for companies when they are planted and implemented carefully maximizing the benefits to organizations. However, as the adoption of AI automation increases, there is a necessity for well-defined guidelines, regulations, measures, and policies to ensure responsible and ethical use. Hence, organizational capabilities and understanding of the business objectives of RPA

within AI implementation are critical to the success of RPA projects. Inadequate understanding of what RPA and AI algorithms can achieve and where it can be implemented, lack of managerial support, and the fear of job loss by employees are identified as key challenges to process automation (Suri, Elia, & Hillegersberg, 2017). Organizations should carefully assess their business processes and identify areas where RPA could add value by enhancing their processes, while investing in training, and preparing their employees to work along with RPA and AI capabilities, ensuring a stable and successful transition to automation.

In conclusion, this study reveals RPA-AI integration holds tremendous potential for transforming business process automation, with diverse applications across sectors. The applications analyzed provide actionable insights for practice on automation opportunities. However, the limitations highlighted reflect existing technical constraints and adoption challenges that must be carefully evaluated. Organizations must assess processes suitable for intelligent automation and mitigate attendant risks through governance and training. For researchers, the study bridges an important literature gap, but further work is needed to develop theoretical frameworks and evaluation models for RPA-AI implementation, along with studies focusing on change management aspects. As RPA and AI functionalities continue advancing, future research must also explore intelligent process automation using emerging techniques like natural language processing, smart contracts, and predictive algorithms.

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