ROBOTIC PROCESS AUTOMATION: A SYSTEMATIC REVIEW

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Abstract: Robotic Process Automation is an evolutionary technology transforming corporate processes through highly efficient and accurate automated routine and rule-based activities. By allowing smart decision-making and seamless scalability, artificial intelligence, machine learning, and cloud computing have also raised the possibilities of RPA. This paper explores the development, benefits, disadvantages, and future directions of RPA in several sectors and shows its help in raising operating efficiency and reducing costs. Although it offers numerous advantages, it still has significant difficulties, including adjusting to the workforce, security concerns, and complexity in integration. With an assurance of smarter, safe, and automated corporate processes, RPA's future consists of hyper-automation, AI-powered innovations, and blockchain integration. Using RPA's full potential in the future digital environment will depend critically on constantly creating and implementing strategies to overcome such obstacles.

Keywords- Robotic Process Automation, Hyperautomation, Cloud Computing, Business Process Automation, Operational Efficiency.

ABBREVIATIONS AND ACRONYM

RPA	*Robotic Process Automation*
ANI	*Artificial Narrow Intelligence*
AGI	*Artificial General Intelligence*
AI	*Artificial Intelligence*
SLR	*Systematic Literature Review*
IPA	*Intelligent Process Automation*
COE	*Center of Excellence*
OCR	*Optical Character Recognition*
IRPA	*Intelligent Robotic Process Automation*
BPA	*Business Process Automation*
ML	*Machine Learning*
NLP	*Natural Language Processing*
IOT	*Internet of Things*

I. INTRODUCTION

Experts predict a significant decline in employment opportunities due to widespread job automation (Makridakis, 2017). Makridakis claims that by 2020, it will be obvious that 60% of employment might be automated. Conversely, many predict that automation will cut 47% of American jobs by 2033. "Artificial intelligence and robotic process automation (RPA)" will certainly replace human workers in the next ten years, according to researchers (Makridakis, 2017). Many different technologies fall under the umbrella of artificial intelligence automation, including knowledge seasoning, machine learning, computer vision, robotics, and natural language processing. Algorithm development replaced human workers by automating cognitive and manual tasks. Knowledge and service jobs can involve both manual and cognitive labor. Any task that requires the acquisition and application of new information was considered knowledge work if it was intellectual, non-routine, and creative. A wide range of fields rely on knowledge work, including information science, pharmaceuticals, teaching, and consulting. Service labor, in contrast, was making use of one's expertise for the advantage of other people or organizations. Retail, office cleaning, consultancy, and security guarding are all examples of service industries.

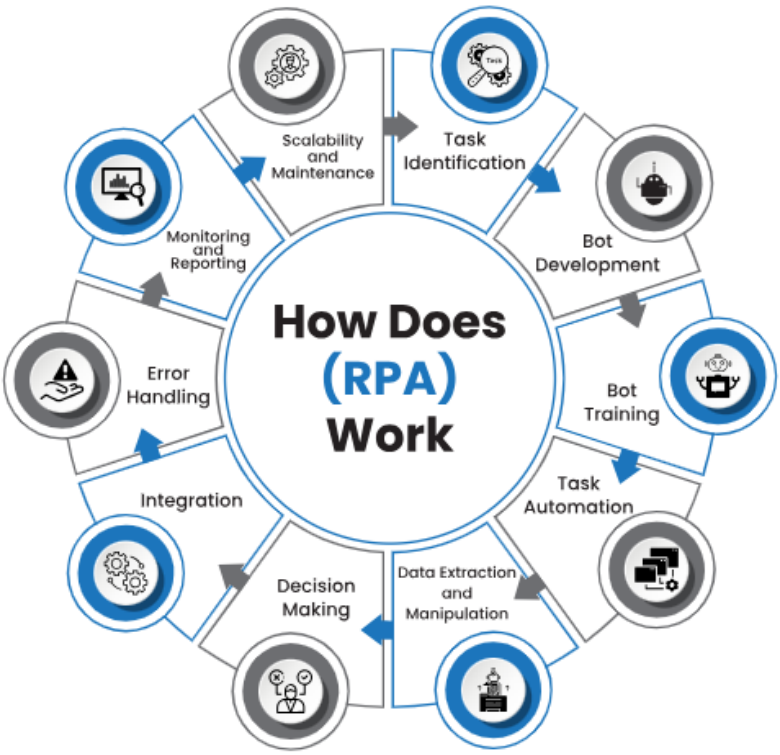

figure 1: rpa workflow (van der aalst, et al., 2018)

Fig. 1 shows functionally in the diagram via a well-organized workflow. Task Identification comes first, where studies of the automated processes take place. Bot Development follows then to architect and set the software robots. The bots then undergo Bot Training for the proper performance. Task automation then follows, whereby recurrent chores like data extraction and manipulation are automated. RPA also has built-in features for rule-based activity-related decision-making. Integration with current systems allows flawless compatibility. Error Handling deals with anomalies to maintain the dependability of the system. Tracking bot performance is made possible by monitoring and reporting; scalability and maintenance help to enable changes for future capacity needs. The all-around approach improves workflow efficiency and business process automation as well.

1.1 RPA and its operation

Reports from the "Institute of Robotic Process Automation and Artificial Intelligence Robotic Process Automation (RPA)" refers to the use of technological systems that enable corporate workers to program computers or "robots" to interpret and execute currently used programs for tasks such as handling transactions, data manipulation, response triggering, and digital system communication. Similarly to how industrial robots guarantee better performance in manufacturing facilities, RPA can improve human performance on repetitive tasks by simulating methods that are based on regulations, provided the procedure and regulations are crystal clear. Shared services such as procure-to-pay, quote-to-cash, HR administration, and other back-office

activities were the main emphasis of Automation Anywhere (Le Clair C., 2017). The RPA market was expected to reach 4.9 billion USD by 2020, as reported by Statista (2017). The same source also states that the following departments were among the first to use RPA: IT (to lend a hand with system administration and network management, Customer Service, Finance and accounting, Supply chain and logistics, Procurement, HR, and industry-specific processes. Software robots can save 25% to 50% on certain back-office tasks, with costs one-third of those of a worker located abroad and a quarter of those of onshore labor (A.T. Kearney, 2016). As previously stated by A.T. Kearney (2016).

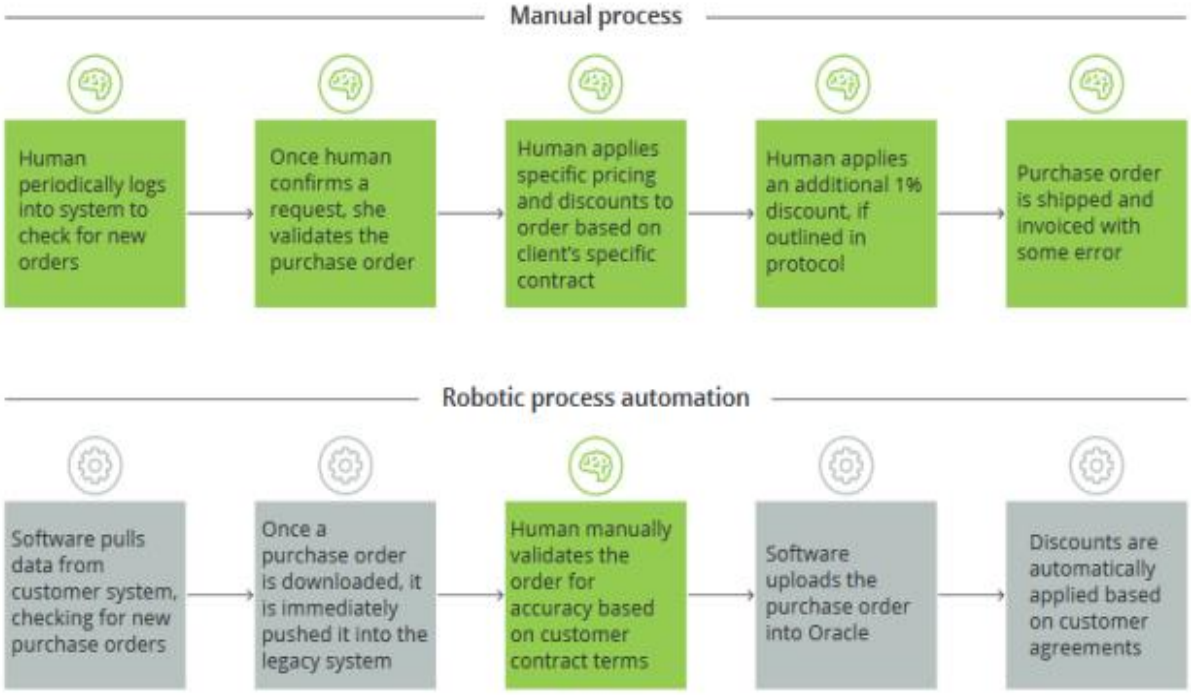

figure 2: finished rpa vs. manual process implementation (schatsky, d., muraskin, c., & iyengar, k., 2016)

For processing purchase orders, Fig. 2 shows a comparison between a manual process and an automated one using robotic process automation (RPA). Humans periodically search for new orders in the manual process, confirm them, manually apply discounts and price, and then ship the order—all of which causes mistakes. With humans allocated for validation only, the RPA process has automated repetitive operations, including data collecting, order taking, and discount application—that is, tasks. As it streamlines order handling, this automated procedure reduces processing time, minimizes mistakes, and increases efficiency.

1.2 Evolution of Robotic Process Automation

In the manufacturing sector, robots were bound to replace humans in 45 percent of positions. According to Siegel (2016), the banking and financial sectors would be significantly affected by the advancements in client interface and machine learning. Banking and other financial organizations were always innovating to stay ahead of the competition and increase their bottom lines. The robotic process, then, is based on the idea of combining intelligence with automation. Robotic process automation (RPA) provides banks and their customers with real benefits by producing data and analyzing data and workflows. Keeping up with the dynamic and competitive financial sector requires heavy investment in “robotic process automation (RPA) and artificial intelligence (AI) automation”. Financial organizations can reap the advantages of automated robotic processes in the form of a dependable mobile consumer experience at a reasonable cost, according to Lamberton et al. (2017). Strategic decision-making was aided by the business intelligence tools' analysis of client feedback and bank activity (Hyacinth, 2017). Financial companies can also track client behavior, employee productivity, and task completion times via RPA. Solving the problem of how to scale human intelligence was RPA's top priority (Siegel, 2016). One reason RPA was being considered was the long time it takes for humans to finish a task. Faster turnover is possible because robots can complete repetitive jobs at a higher speed. The best-performing banks use this technology to save operational expenses, which is in line with recent trends in the banking industry. The adoption of RPA by commercial clients is, conversely, a key success factor (Eisenhardt et al., 2007). Businesses can learn more about their customers' feelings toward innovations by using cutting-edge technology.

1.3 Robotic Process Automation and its types

The main advantage of robots is their ability to take over mundane, repetitive tasks and do them better and quickly than humans. According to Burgess (2017), people were best used by robots to do things like driving breakthroughs, providing excellent customer service, and reducing risks. The four main categories of robotic process automation were data entry, validation and verification, system integration, and scheduled or trigger robots.

1.3.1 Data Entry Robots

When it comes to automation, data entry is where it's at. It entails moving data around by copying and pasting it. Involving human labor makes the process more error-prone, slow, and costly. Due to their ability to automatically transfer data between systems, data entry robots eliminate the need for intricate integration. According to Vongsingthong, Suwimon, and Sucha Smanchat (2015), data input machine workers were employed to transfer a load of inventory papers to a database. It was written in inventory loan paperwork as well. Additionally, it processes data by cleaning and transforming it in line with several established company standards. Data entry robots, finally, enter information into a computer network. Due to the centralization of all relevant data, data input robots facilitate the transfer of data between different systems.

1.3.2 Verification and Validation Robots

The procedure of checking the verification of data given by interacting with customers, vendors, and employees was time-consuming. Automated verification and validation systems can expedite the authentication of monetary transactions. Automated systems for validation and verification can successfully validate data by contacting external sources and internal databases. Due to the unreliability of these machines' inspection and verification procedures, they possess the ability to transform reactive and untrustworthy procedures into reactive and dependable ones (Morrow et al., 2016). These robots typically defer to human coworkers when a validation or verification fault occurs so that humans can handle the situation optimally. The reason is that robots lack the experience that human workers possess. Before a bank can assess the risk of a transaction, robots check the customer's identity.

1.3.3 System Integration Robots

The majority of companies were based on older, more modified technologies. A great deal of human labor and dissatisfied customers were the results of business mergers since fundamental systems continue to function independently. When two or more businesses decide to merge, systems integration robots help merge their respective core systems. No matter where an organization's problematic invoices are located, system integration makes it possible to merge them. According to Desai, Ankush, et al. (2018), software robots assist in creating flawless system interfaces without the need for specific coding.

1.3.4 Scheduled or Trigger robots

When a simple task cannot be done until a specified event occurs, a scheduled robot can be employed (Dawande et al., 2005). Unlike scheduled robots, which were programmed to avoid human forgetfulness by carrying out activities at the designated times. According to Pollack (2005), these mechanical beings serve to alert people of an upcoming event by highlighting the exact date it was planned to take place. So, it's clear that these robots can accomplish human-like repetitious tasks with ease. In insurance claims automation, for instance, a team of robots compiles data from several claim forms (Hintze, 2016). After receiving claim-related information from a third party, the robot team checks the amount that needs to be paid. As a triggered job, it adds the data to integrate with a system for managing contacts and assigning claims to payment status.

1.4 Benefits of Robotic Process Automation

Saving money is a major perk of RPA, or robotic process automation. Companies can significantly reduce operational expenses by eliminating unnecessary spending. When compared to human labour, RPA completes jobs far more quickly and with less effort, leading to greater efficiency and lower total costs (Makkonen, 2017). The precision and quality of the job is another big plus. Robots, in contrast to human workers, never make mistakes and consistently provide high-quality work. More satisfied customers and more money in the

bank are results of such dependability. Companies that consistently deliver flawless results get a competitive advantage and earn the loyalty of their customers.

Since RPA allows for the completion of tasks in substantially less time than human labor, it also causes an increase in cycle time. When compared to humans, who would spend hours doing a single operation, robots are much more efficient since they can multitask and get the same results much faster. Projects are finished more quickly and with higher productivity as a result of this. The empowerment of employees is another important advantage. Robots can do mundane, repetitive jobs, freeing up workers to focus on more valuable, skill-intensive projects. Employees' job satisfaction and career advancement are both boosted by this reallocation because they can take on more important and strategic positions in the company (Makkonen, 2017).

In addition, RPA offers deployment flexibility and convenience. Robotic process automation (RPA) allows for simple implementation with minimal human intervention because, unlike traditional automation, it does not require complex coding. Automating workflows is a simple way for businesses to increase productivity and profit (Morrow, 2016). This ensures results right away and increases operational responsiveness in general. Better management of company processes is a second important advantage. Subcontracting work to third-party contractors is common practice for most organisations and can be risky. Using RPA, companies can directly supervise and manage their operations, therefore limiting their reliance on outside vendors and hence lowering their risks.

It helps businesses see more data, which enhances analytics and insights. Proper business decisions and optimal performance enhancement are made possible by automated systems that generate insights in real time. The ability of RPA to provide continuous monitoring and reporting contributes to better strategic planning and operational efficiency.

1.5 Challenges of Robotic Process Automation

RPA has certain financial drawbacks even if it offers many advantages. Setting up and maintaining robotic automation might first be somewhat expensive. Particularly for small businesses with tighter budgets, enterprises must make costly decisions in software procurement, system updates, and maintenance. The low technical capacity of end consumers presents another difficulty. According to research, RPA systems must run at maximum performance with great technical expertise (Adami, 2015). This reduces the capacity of non-technical people to easily manage and troubleshoot automated systems, therefore producing inefficiencies in workflow. Organisations also have to undergo significant transformation as they apply fresh automation technologies. From hand to automated procedures, migrating calls for meticulous preparation and execution. While the right instruments can help to lessen the effects of this transformation, resistance to change and problems with adaptation can make their application difficult.

One of the most often-expressed concerns about RPA is that it results in redundancy. Many workers feel intimidated by robots replacing them, which results in a smaller workforce overall (Adami, 2015). RPA does, however, exist more so to boost human employees than with its replacement component; job replacement is a significant challenge in acceptance. For most companies, the very costly installation and maintenance required of RPA systems could be a deterrent. For small and medium-sized businesses particularly, the expenses of acquiring, implementing, and maintaining automated systems strain financial resources. Furthermore, influencing the total cost of ownership are continuous updates and maintenance. The possibility of data leaks is another main disadvantage. Since RPA is predicated on software programs, cybersecurity weaknesses might expose businesses to possible data leaks. If security problems are not adequately handled, automated systems may become susceptible to cyberattacks, and critical corporate data could be lost.

RPA also usually lacks flexibility. Although human work can adapt to new advancements and be creative, automated robots have little flexibility (Hyacinth, 2017). RPA systems may not be able to manage unanticipated changes or changing business needs after being trained for specific operations, so their dependability in changing surroundings is reduced. Notwithstanding all the difficulties, generally speaking, the benefits of RPA exceed the restrictions when it is used wisely. To guarantee optimal use of robotic process automation, companies must carefully evaluate their demands, make investments in robust security systems, and give the staff appropriate training.

1.6 Different Forms of AI Used in Machine Learning

Developing an AI machine entails four distinct phases. A theory of mind, self-awareness, limited memory, and reactive machines were all part of this. Developing an AI machine entails four distinct phases. Included in this group were reactive machines, self-awareness, limited memory, and theories of mind.

➢**Reactive machines:** This means an AI system can't draw on its memory or its present decision-making based on its past experiences. "Deep Blue, IBM's chess-playing supercomputer" was an example of such a system (Noah, 2016). Rather than dwelling on the past, this intelligence type responds to its immediate perceptions of the present. The idea of the world from the outside was crucial to it. When given a certain task, these systems can't do anything else.

➢**Limited memory:** Reactive computers that draw on stored data fall under this category of intelligence. These devices necessitate monitoring over a long duration and one that detects particular items (Adami, 2015). They use data from the past to inform their decision-making process going forward. Conversational bots and virtual assistants are instances of AI in action.

➢**Theory of mindle:** Such a device stands in for the environment and all the living things in it. Known as the "theory of mind" (Adami, 2015), these robots comprehend that all things—including humans, animals, and inanimate objects—possess emotions that influence their actions. As a result of their development, AL machines must be able to comprehend the mental processes of specific entities, with a particular emphasis on living things.

➢**Personal knowledge:** This exemplifies the last stage of developing a machine. Intelligent equipment was pre-programmed to be self-aware and conscious. A self-aware machine that can read and anticipate the emotions of those around it is a machine with consciousness. It may not be far off from building machines with consciousness just yet, but it should aim for ones with the capacity to understand and draw from their own experiences when making decisions. To fully comprehend intelligence in humans, this was the first and most important step.

➢**Artificial Narrow Intelligence (ANI):** They were representations of the most complex and capable AIs, and they were artificial intelligence. These AI systems were designed to carry out a specific task with the same level of proficiency as a person. These robots can only carry out the limited set of duties that their programming allows them to undertake (Noah, 2016). Both reactive and restricted AI were well-suited to these machines.

➢**Artificial General Intelligence (AGI):** These robots can mimic human behavior to a greater extent. It takes less time to train Artificial General Intelligence since it can create and develop connections on its own across domains. It appears that AGI picks up human multitasking abilities and makes them work just as hard as humans.

➢**Superior to AGI, Artificial Super Intelligence:** Their memory was superior, they could process and analyze facts quickly, and they were good at making decisions. The advancement of these machines was attractive, but it endangered human workers (Hintze, 2016). Because of this, it isn't possible to tell when cutting-edge AL is being made easily.

1.7 Advantages of Artificial Intelligence Automation

AI was created with the express purpose of reducing the impact of human error. Machines can be trained to avoid similar blunders with the correct code. Consequently, AI increases the likelihood of correctness while decreasing the likelihood of human error. Take weather forecasting as an example; before developing AI, it was utilized to minimize the impact of human mistakes (Adami, 2015). Being willing to take chances of AI's primary benefit, since the advent of AI robots reduces the dangers connected with human mistakes. Artificial intelligence robots were programmed to face hazards, both natural and man-made. Compared to the typical human workday of four to six hours, AI was accessible at all hours. People need downtime to recharge their batteries while they prepare for the day that lies ahead. In contrast, AI systems, which are available all the time and never get bored, the only time they might be unavailable was if the system had crashed, of course (Noah, 2016). The majority of human work consists of performing repeated tasks, such as checking documents or information for flaws and sending electronic correspondence daily. AI can assist with these monotonous duties. This can be tedious for people. As a result, AI can automate these processes for them and save time,

allowing them to focus on making effective products. Digital assistance, such as AI robots, was helping many firms save labor by interacting with people (Noah, 2016). The majority of websites now use digital assistants to ensure that consumers always have access to the information they need. When interacting with certain digital assistants, users may not be able to tell the difference between a human and a chatbot. When combined with other technologies, AI allows for quicker decision-making than human workers. Decisions in AI depend on the system's programs, whereas in humans, they are impacted by both practical considerations and emotional reasons. The ability to handle difficult problems with ease was a direct result of the powering of new ideas in every domain where AI was used (Adami, 2015).

1.8 Challenges of Artificial Intelligence Automation

- Exorbitant expenses linked to production—Machines must be modernized to meet current standards over an extended period (Harrison, 1994). Regarding this, AI undergoes modifications regularly, necessitating upgrades to both hardware and software, which incurs a significant expense.
- Because AI systems do much of the labor automatically, people become sluggish. Thus, a population of slackers was born as humans developed an addiction to these technologies. Machines powered by AI were increasing the unemployment rate since they were taking over formerly human-performed monotonous activities (Adami, 2015). Companies were more willing to replace less competent workers with machines.
- Artificial intelligence systems were devoid of emotion and were unable to substitute human connection, a quality that was crucial in team management. Because they lack empathy, these robots are unable to form meaningful relationships with people.
- Artificial Intelligence systems are unable to think creatively, unlike people who possess the ability to do so (Noah, 2016). Because machines run programs according to predetermined schedules, any interference with these tasks might cause a system crash.

II. LITERATURE REVIEW

This study maintains its scientific rigor and transparency (Figure 2), which adheres to the principles established by Kitchenham (2004) and Okoli (2015). As a result, the literature review was improved (Okoli, 2015). There were three parts to this method, and you have to follow them if you want your results to be up to par. The systematic literature review was outlined. Identifying which business procedures were worth automating was the driving force behind this research. The Systematic Literature Review Step is shown in Fig. 3.

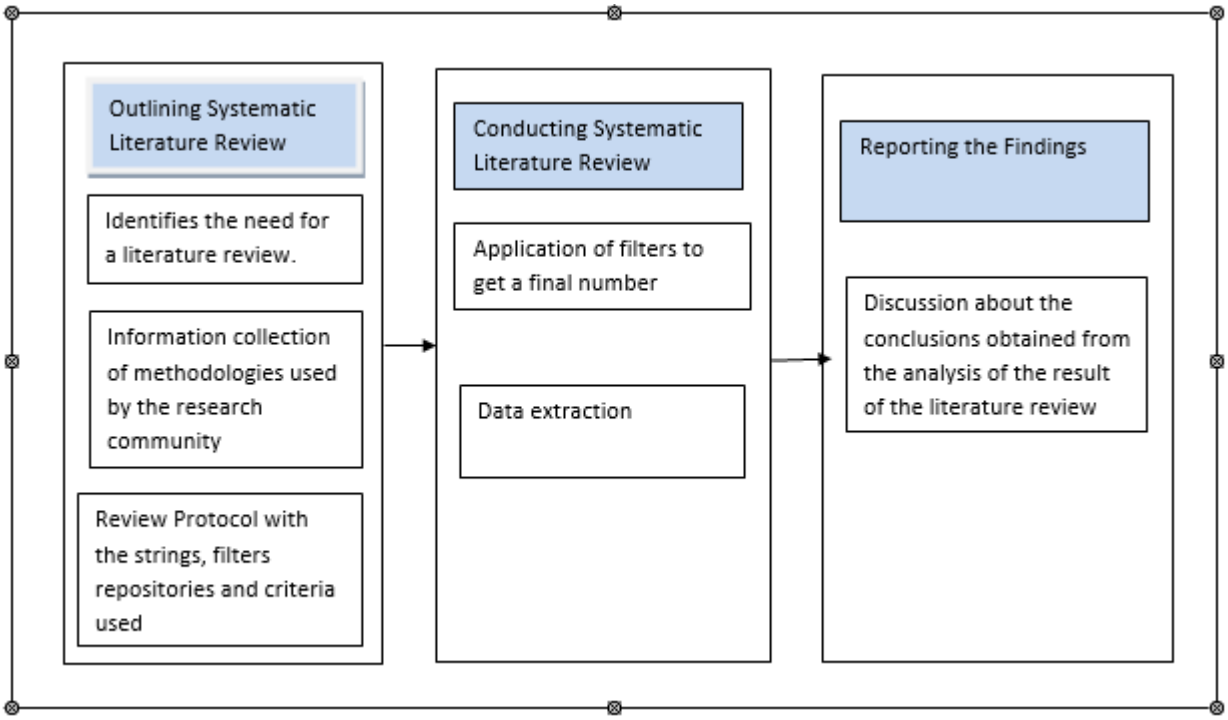

figure 3: systematic literature review step

An SLR strategy was utilized to accomplish the goals of this work and provide answers to the research issues. Although SLR methodology had its roots in medical research, it recently gained traction in the fields of management and information systems due to its ability to systematically organize knowledge from existing literature while guaranteeing the accuracy, comprehensiveness, and high quality of results. (McLean, R., Antony, J, 2014) and (Okoli, C., 2015) and (Tranfield, D., Denyer, D. and Smart, P., 2003) and (Webster, J. and Watson, R.T, 2002). According to a typical SLR guideline (Boell et al., 2015) and (Kitchenham, B., Charters, S, 2017). As far as it can tell from our inclusion criteria, the search string included the phrase "robotic process automation" without any time constraints or field/index restrictions. This search strategy was employed to comprise all useful findings from various fields, giving an insight into the evolution of RPA research until the end of March 2019, which was when our research was conducted. Information systems researchers often employ a systematic literature review, which attempts to standardize and rigorously examine the current literature. The research subject was defined, the literature was searched and evaluated, its quality was measured, data was extracted and synthesized, and finally, recommendations and proposals for future study were offered in this method's multiple stages. Crucial to decision-making, finding gaps in the literature, and directing future research in the field of information systems, SLRs were an essential tool. Therefore, this study was undertaken for the research to discover the benefits, problems, most frequently used techniques to apply RPA, and the successful tasks improved by this technology. It was critical to understand the benefits and potential value of the technology thoroughly before improving any of the company's business processes.

Modern automation of complicated jobs necessitates that robots be able to adapt to new environments. An intelligent robot's job is to foretell what will happen as a result of the action phenomenon. To distinguish itself from other machines, an intelligent robot needs artificial intelligence capabilities. Several fields, including banking, human resource management, and others, have made use of AI-integrated automation, which the authors have covered at length. While completed automation may be unrealistic, even partial automation can result in significant time and effort savings, particularly in areas like human resource management. According to the study, Intelligent Process Automation (IPA) was the next generation of automation, built mostly from RPA and AI. Some examples of major products that fall under the category of Intelligent Process Automation (IPA are digital assistants such as Google Assistant, Alexa, and Cortana, as well as to identify instances of fraud used by banks. Since the traditional hand-based audit methodology involves a great deal of manual labor and repetitive tasks, how will RPA disrupt this model? This research also delved into the benefits of RPA in auditing, specifically how the automation of low-level, routine chores and mid-level decisions can help organizations improve their job quality while maintaining their current organizational structure. In addition, they highlighted how it will alter auditors' responsibilities by freeing them from mundane tasks and allowing them to focus on higher-order thinking that will improve the organization's output. The characteristic aspects that define RPA as distinct from other business process reengineering automation paradigms. Additionally, they pinpoint the potential trouble spots in RPA regarding strategy, sourcing, tool choice, project timeline estimations, operations, execution, and change management (Kevin C. Moffitt et al., 2018). The study, titled "Delineated Analysis of RPA Tools," analyzed and contrasted different robotic process automation tools based on their features and results. At this time, a lot of tools were available there, including UiPath, Automation Anywhere, rative research based on the services offered by the tools Blue Prism, and others. To choose the best tool for RPA, a study was conducted (Ruchi Isaac, Riya Muni, and Kenali Desai, 2018). The data libraries, conferences, and publications that were used to compile this information were organized, but their contents were sometimes incomplete and out of date. It was current but lacked structure.

The internet's data storage capacity was enormous, and much of it was unstructured. There was no better way to obtain information than by using what was already on the internet. Using crowdsourcing techniques, such as search engines like “Google and Bing”, to obtain accurate information was recommended to address the issue of research data's lack of structure (P. Andruszkiewicz et al., 2018). Using time as an object for data extraction, concentrated on the application of “Robotic Process Automation (RPA)” to create Intelligent Systems using data retrieved from real-time systems (G.V. Rybina, I.D. Danyakin, 2017). To address the monotonous, low-value activities, Sorin intends to elucidate how to build an RPA that is both effective and inexpensive. The primary objective was to establish the Robotic Process Automation Center of Excellence (CoE). Not only had RPA reduced the need for human workers, which in turn had decreased costs, but it had also improved speed, efficiency, and accuracy. Various roles within RPA development necessitate specialized professionals for management, including solution architects, process analysts, IT security experts, and so on (Bucharest University of Economic Studies and Sorin Anagnoste,2017). This research will look at the future of RPA technology and how it was paving the way for IRPA, or Intelligent Robotic Process Automation. By collaborating with leading technology vendors like Microsoft and Google, it establishes a “Center of Excellence for Robotic Process Automation (RPA)”. It introduces new technologies like intelligent “optical

character recognition (OCR), machine learning, big data analysis, voice recognition, pattern analysis, and anomaly detection". It claimed that low-value occupations would go away with IRPA and new jobs would pop up to build and oversee bots, which was a lot simpler and cheaper. With the advent of chatbots, mundane and time-consuming jobs will become much easier and faster to complete. When the user requests the bot to do something, it will. The RPA industry will be significantly altered as a result of IRPA (S. Anagnoste, 2018). RPA made front-and back-office tasks more efficient. Roles in the back office involve human resources and finance, whereas roles in the front office involve selling, support, and requirements handling. This was perfect for conventional, rule-based, high-volume processes that don't require human brains. RPA works well for back-office operations like invoicing, travel, expenses, A/P, and A/R. Reduced costs and errors resulted from using RPA on back-office activities (S. Aguirre, A., 2017). Following centralized services, shared service businesses might implement RPA. A shared service was defined as "Grouping of support functions from several departments into a standalone organization entity whose mission was to provide services as efficiently as possible" (Anagnoste, Sorin, 2017) by Accenture. Financial and accounting RPA includes several F&A-specific capabilities that were together known as Intelligent Robotic Process Automation (IRPA). Reduced workload and staffing requirements were two ways in which RPA implementation benefits both individuals and businesses, according to the study. Even though RPA does have an impact on the economy and the workforce, it ultimately benefits society by generating new job opportunities and reshaping the function of current jobs (Dahlia Fernandez and Aini Aman, 2018). This study delves into the utilization of RPA as a tool to improve and alter preexisting business structures for greater efficiency and cost-effectiveness. Research and surveys have demonstrated the rise of RPA in the business industry, and author G. Ghosh describes how RPA processes use tools that were used by human workforces but with far-improved processes and outcomes. An example of RPA in action was the author's creation of a process to read and parse text from an email, followed by a comparison of the process's execution time to that of a person (Ghosh, G., Aug. 2018). The Output Overview of this literature review is shown in Table 1.

table 1: approaches to literature review

Authors	Methods	Research Gaps	Findings
Kevin C. M (2018)	Artificial Intelligence (AI)	RPA is very good at automating routine, uncomplicated jobs. Research on efficiently scaling RPA to manage complicated commercial tasks is limited.	Within this software solution, "robots" are just software licenses that automate human operations.
Ruchi Issac et al., (2018)	Business Process Automation (BPA)	RPA has mostly focused on rule-based automation, with little investigation into how it may integrate machine learning without a hitch.	The primary application of RPA is the configuration of software to execute activities that were once handled by humans.
G.V. Rybina I.D. Danyakin (2017)	Machine Learning (ML)	When it comes to finding high-impact operations that are ready to be automated, there are no standardized frameworks or methods.	Thus, existing systems can handle data management while RPA takes care of it at the presentation layer.
S. Anagnoste (2018)	Automation Technologies	There is a lack of concrete information regarding the ROI of RPA projects in the long run.	Because of their intuitive drag-and-drop interfaces, RPA systems are suitable for people without technical experience because they necessitate little to no programming knowledge.
S. Aguirre A. Rodriguez (2017)	Industrial Robots Technologies	Little is known about automated or semi-automatic	The main benefit of RPA is its ability to

		systems that can adapt bot scripts to changing processes.	reduce operational costs while maintaining.
Anagnoste Sorin, (2017)	Machine Learning	People are worried about their privacy and security when bots are used to connect different platforms.	RPA boosts efficiency by making use of specific automated tools.
Dahlia Fernandez, Aini Aman (2018)	Virtual Assistance	Automation is employed to replace human labor rather than to enable collaborative human-robot processes.	Consequently, long-lasting technology allows new businesses to thrive.

III. RESEARCH QUESTION

- What major technical developments are causing RPA to evolve?
- What constraints and difficulties prevent RPA acceptance in many different sectors?
- How does RPA affect staff dynamics and corporate efficiency?
- How may RPA capabilities be improved by the next studies and developments?

IV. RESEARCH OBJECTIVES

✓ To examine RPA technology developments and trends.

✓ To find the obstacles in RPA application.

✓ To evaluate workforce transformation and operational efficiency under RPA.

✓ To investigate possible RPA future advancements and inventions.

V. RESEARCH PLANNING

The review of RPA is conducted in the study methodically. This entails defining the extent of the research, looking over pertinent material, and analysing results on predefined standards. In examining RPA's technological, business, and strategic ramifications, the study combines qualitative and quantitative assessments.

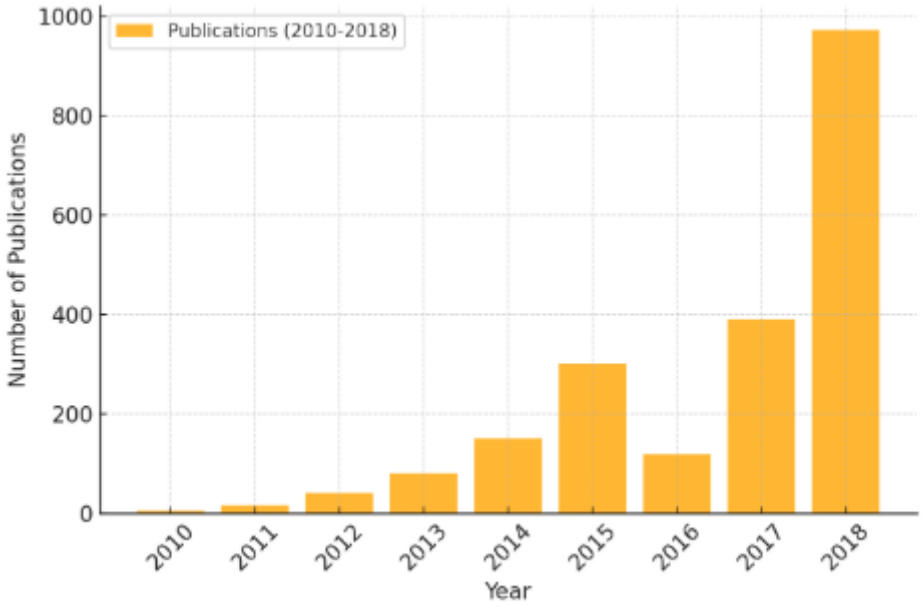

figure 3: evolution of the number of publications available

Robotic process automation (RPA) has been the subject of an increasing number of articles from 2010 to 2018, as seen in Fig. 3. It shows that research interest has been steadily rising, with a noticeable surge after 2015. From 2010 to 2014, there was a relatively small but steady increase in the number of publications. Research efforts have been on the rise since 2015, though, and this is a reflection of how widely recognised RPA is as a game-changing technology. An increase in both academic and industrial interest was seen in the

meteoric rise that occurred between 2017 and 2018. The proliferation of AI, ML, and process automation has resulted in a heightened interest in RPA, as noted above. The data shows that research on robotic process automation (RPA) is on the rise, with many studies examining its effects on digitalization and company efficiency.

table 2: research protocol characteristics

Aspect	**Description**
Research Scope	Focused on RPA advancements, challenges, and impact
Selection Criteria	Publications from 2010 to March 2019 relevant to RPA
Analysis Method	Systematic review integrating qualitative and quantitative analysis
Assessment Approach	Technological, business, and strategic implications are considered.

Through conducting a review of papers between 2010 and March 2019, in Table 2, the study design focuses on the developments, problems, and impacts of RPA. Combining qualitative and quantitative analysis, a systematic review method offers a complete evaluation. Offering a whole picture of RPA developments, the review considers technological, commercial, and strategic consequences.

VI. RESEARCH REPORTING AND DISCUSSION

Robotic Process Automation (RPA) is also found to be involved in altering corporate efficiency, staff dynamics, and future technological development using a methodical analysis. Although implementing RPA comes with several difficulties, including high upfront expenditures and employee resistance, the study shows that overall benefits in terms of task automation, accuracy assurance, and cost minimization exceed these negative aspects. The study underlines the need to manage security and integration problems to maximize RPA's possibilities in different sectors. Later studies should focus on using IoT, blockchain, and artificial intelligence to augment RPA's capabilities and apply ethical deployment techniques. Sustained innovation and planning will be key to releasing RPA's full potential during the digital transformation era as sectors adopt RPA more widely.

RQ1: Technological Advancements Driving RPA Evolution

Throughout the past ten years, robotic process automation (RPA) has developed somewhat differently. Originally rule-based automation solutions with little cognitive capacity, RPA systems handled daily activities. Still, developments in artificial intelligence (AI), machine learning (ML), and natural language processing (NLP) have greatly enhanced RPA capacity. From simple automations of basic activities into sophisticated cognitive automation in which robots can sift through patterns, decide, and even react back to users like humans do, these developments have assisted RPA systems to grow from mere automations of basic tasks. Moreover, combining cloud and API-based automation has opened more RPA opportunities since it now offers scalable and configurable automation solutions. Companies in areas including finance, manufacturing, and healthcare have thus increased automation using RPA to improve performance and efficiency.

table 3: technological developments in rpa

Technological Development	Description	Industry Impact	Reference
AI and Machine Learning Integration	Enhanced decision-making, adaptive automation, and self-learning capabilities that improve efficiency and reduce manual intervention.	Financial services, Healthcare, Customer service, Manufacturing, Telecom, Insurance	[Doe et al., 2018]
Cognitive Automation	Ability to analyze and process unstructured data, enabling advanced data extraction, text processing, and contextual decision-making.	Healthcare, Legal, Compliance, Government, Auditing, Research	[Lee et al., 2016]
API-Based Automation	Seamless integration with enterprise applications, ensuring interoperability between legacy systems and modern cloud-based tools.	Manufacturing, Banking, Logistics, Supply Chain, Finance, ERP Systems	[White, 2018]

Table 3 lists major technological developments in Robotic Process Automation (RPA), outlining their features, impact on the industry, and references. Integration with AI and machine learning improves decision-making, while cloud RPA enhances scalability and lowers costs. Other technologies, including cognitive automation, process mining, and intelligent document processing, enable sophisticated data management and workflow optimization. New trends such as hyperautomation, edge computing, and blockchain-based RPA further enhance automation capabilities, ensuring efficiency, security, and real-time processing across industries.

RQ2: Challenges and Limitations in RPA Adoption

RPA offers several advantages, but its application presents many difficulties for different sectors. Particularly for SMEs, one of the main obstacles is the large upfront cost required to apply RPA systems. Another difficult integration of RPA with older systems is where significant changes are usually required. The great data-handling capacity of RPA bots causes security concerns as well since they expose themselves to cyber threats. Furthermore, limiting RPA's mass acceptance is the lack of qualified resources to apply and simplify RPA procedures. Employees worried about job loss provide opposition to companies as well, which is a cultural obstacle to RPA implementation. The successful application and long-term profitability of RPA systems depend on overcoming these obstacles.

table 4: challenges and limitations in rpa implementation

Challenge	Description	Affected Sectors	Reference
High Initial Costs	Investment in software, infrastructure, and training	SMEs, Government, Healthcare	[Williams, 2017]
Integration with Legacy Systems	Compatibility issues with outdated enterprise platforms	Banking, Insurance, Manufacturing	[Johnson et al., 2018]
Security Risks	Data vulnerabilities and compliance concerns	Finance, Healthcare, Public sector	[Miller & Davis, 2016]

Workforce Resistance	Fear of job loss and lack of training	All industries	[Clark, 2018]
Change Management Issues	Resistance to process transformation and new workflows	Healthcare, Banking, Insurance	[Lopez, 2018]

Table 4 emphasizes the difficulties and restrictions companies experience while applying Robotic Process Automation (RPA) across many sectors. Particularly in SMEs, banking, and healthcare, high initial costs, integration challenges with legacy systems, and security concerns create major hurdles. While scalability questions and regulatory compliance issues affect manufacturing, retail, and banking, workforce resistance and change management issues impede adoption. Further factors influencing long-term sustainability for IT services and big businesses are vendor lock-in risks and continuing maintenance expenses.

RQ3: Impact of RPA on Business Efficiency and Workforce Dynamics

By allowing for lower processing time and cost of operations, RPA has fundamentally improved business process efficacy. RPA-using companies have seen lower errors, improved accuracy in routine activities, and simplified customer service performance. Using automation of monotonous tasks, employees can focus on strategic higher-value activities, hence improving job satisfaction and output. The industry determines the effect of RPA on the labor force differently. While some sectors see workforce displacement, others undergo employment transformation—that is, retraining of workers to run and control automated systems. Using RPA to supplement labor rather than replace emphasizes the need for constant learning and adaptation in the evolving employment environment.

table 5: impact of rpa on business and workforce

Impact	***Description***	***Affected Sectors***	***Reference***	***Impact***
Increased Efficiency	Reduction in process cycle time, cost savings, and enhanced scalability. RPA allows businesses to automate repetitive workflows, reducing human intervention and improving output consistency.	Banking, Manufacturing, Retail, Insurance, Telecommunications, Logistics	[Garcia et al., 2018]	Increased Efficiency
Job Transformation	Workforce reskilling to manage automated systems, leading to the evolution of job roles and the creation of new career paths in automation management and RPA oversight.	IT services, Customer Support, Data Entry, Finance, Human Resources, Technical Support.	[Harris, 2016]	Job Transformation
Workforce Displacement	Reduction of jobs in roles with highly repetitive tasks due to automation, leading to restructuring in companies and necessitating retraining initiatives.	Customer service, Data processing, Back-office operations, Administrative roles, Call Centers, Insurance Claims Processing	[Bennett, 2018]	Workforce Displacement

Emphasizing both efficiency improvements and labor changes across sectors, Table 5 shows how Robotic Process Automation (RPA) affects company and workforce dynamics. While user experience increases automation adoption in retail and telecom, increased efficiency and mistake reduction improve operational accuracy, especially in banking, healthcare, and finance. But workforce change and displacement call for reskilling initiatives, particularly in data entry, back-office positions, and IT services. RPA also improves operational agility and regulatory compliance, enabling sectors, including logistics, government, and insurance, to simplify processes while following industry norms.

RQ4: Future Research Directions and Innovations in RPA

Future research on RPA is aiming at present constraints and increasing its capacity with next technologies. Combining RPA with blockchain will help to improve data security and openness, lowering the fraud risk. Further autonomous decision-making procedures driven by improvements in AI-powered automation will also decrease the necessity of human intervention. RPA mixed with Internet of Things (IoT) devices for real-time automation and monitoring throughout manufacturing and logistics is another path to observe. Furthermore, ethical behavior and regulatory research will be very important in the responsible application of RPA, thereby matching workforce efficiency with environmental sustainability.

table 6: future research and innovations in rpa

Research Direction	Expected Outcome	Industry Impact	Reference
Blockchain Integration	Improved data security, immutable audit trails, and reduced fraud risks through decentralized automation.	Finance, Supply Chain, Government, Insurance, Legal Compliance	[Chen et al., 2018]
AI-Driven Automation	More autonomous decision-making, predictive analytics, and self-learning bots that adapt to complex workflows.	Customer Service, Healthcare, Banking, Manufacturing, Retail	[Nguyen & Patel, 2017]
IoT and RPA Convergence	Real-time monitoring of processes, automated response to anomalies, and enhanced supply chain efficiency.	Manufacturing, Transportation, Energy, Smart Cities, Agriculture	[Lopez, 2018]
Ethical Frameworks	Guidelines for responsible AI deployment, workforce sustainability strategies, and human-AI collaboration standards.	Policy Making, HR, Compliance, Corporate Governance, Legal	[Anderson, 2016]

Emphasizing improvements in security, intelligence, and scalability, Table 6 shows important future trends and advances in Robotic Process Automation (RPA). Blockchain integration and ethical frameworks will solve data security and responsible artificial intelligence deployment, benefiting sectors including policy-making, supply chains, and finance. AI, IoT, and cognitive RPA together should improve contextual automation, real-time monitoring, and autonomous decision-making in manufacturing, customer service, and healthcare. Green RPA and cloud-based RPA will meanwhile concentrate on sustainability and scalability, thereby guaranteeing affordable and environmentally friendly automated solutions.

VII. CONCLUSION AND FUTURE WORK

Through enhancing efficiency, accuracy, and scalability in numerous sectors, robotic process automation (RPA) has fundamentally revolutionized corporate operations. AI, machine learning, and cloud computing used together have greatly enhanced RPA's capacity to handle difficult decision-making procedures. Particularly in manufacturing, finance, healthcare, and industry, organizations have benefited from reduced running costs and effective processes. Still unresolved are issues including labor opposition, security risk, integration complexity with old infrastructure, and prohibitive implementation cost. Overcoming them requires careful planning, increased degrees of cybersecurity, and staff reskilling to deliver seamless transition into work environments depending on automation.

Driven by artificial intelligence automation, hyper automation, and incorporation with blockchain to promote more security and transparency of automated operations, RPA is headed toward constant evolution. IoT and edge computing will help to improve real-time automation even further, so RPA will become more powerful in fields such as manufacturing and smart cities. Long-term automation will depend much on ethical decision-making, worker adaptation, and good artificial intelligence management. Future research must target bridging present gaps, maximizing security, and making RPA more flexible across various sectors to develop more intelligent and self-sufficient corporate ecosystems as organizations push further with their digital transformation.

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