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Integrating AI, ML, and RPA for end-to-end digital transformation in healthcare

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Abstract

The amalgamation of Artificial Intelligence (AI), Machine Learning (ML), and Robotic Process Automation (RPA) possesses significant potential for facilitating comprehensive digital transformation in healthcare. Nonetheless, disjointed initiatives, scaling issues, and restricted compatibility impede broad adoption. This article examines current frameworks and techniques, highlighting the cohesive integration of AI, ML, and RPA to optimize healthcare workflows, enhance real-time decision-making, and improve patient outcomes. The research emphasizes progress in predictive analytics and individualized treatment frameworks while examining RPA's function in automating repetitive procedures, including billing and patient data administration, to enhance operational efficiency and alleviate administrative constraints. A comparative study of existing research reveals differing levels of precision and accuracy in RPA implementations, with Ghulaxe Vivek (2024) attaining the highest performance metrics (94% accuracy, 85% precision), while other studies provide significant insights. Findings illustrate the need for integrated, scalable architectures that leverage the strengths of AI, ML, and RPA to facilitate digital transformation that is both sustainable and effective in health care.

Keywords: Artificial Intelligence (AI); Machine Learning (ML); RPA; Digital Transformation; Healthcare Interoperability; Data Integration

1. Introduction

It is catalyzing a significant change within the healthcare industry because of the impetus to enhance patient outcomes, reduce expenses, and boost operational efficiency. Revenue cycle management (RCM), from the time a patient presents to registration, through billing, claims processing, and payment retrieval, is a critical function in healthcare operations [1]. Hence, the implementation of RCM practices establishes and sustains the financial health of healthcare organizations, ensuring that services remain reliable and of high quality for patients [2]. However, many healthcare providers treat RCM as a cumbersome process because it is complex, and the challenges in the process of medical coding, regulatory compliance, and the need for seamless billing remain significant obstacles in this process [3]. RCM has always relied on manual processes, which are not only time-consuming but also prone to errors to implement [4]. Such inefficiency often results in administrative costs, delayed billing, and ultimately, revenue loss. Healthcare companies have traditionally made investments in growing their back-office operations [5] to address these issues, including hiring more people to handle administrative duties. Despite being essential, this strategy has increased operating expenses, further taxing healthcare [6] providers who are already facing financial difficulties. In recent years, with the emergence of Robotic Process Automation, Natural Language Processing, and Generative AI, it has begun to overcome the issues of traditional RCM [7]. For example, repetitive rule-based processes like data entry, claims processing, and billing can be automated at a surprising speed and accuracy with the help of RPA for healthcare organizations [8]. This process generates more reliable and efficient revenue cycles by reducing the burden on human workers and reducing the likelihood of errors. Generative AI, on the other hand, has the potential to revolutionize RCM decision-making processes, from predicting payment trends to resource allocation, due to its ability to analyze large amounts of data and provide

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insights [9]. This will be about healthcare RCM, whereby research "Beyond Automation: Redefining Healthcare Revenue Cycles through RPA and Generative AI, [10]" discusses how these technologies might revolutionize everything. Will explain how RPA and generative AI are catalysts for reinventing the entire framework of revenue cycle management, rather than just being tools for automating current procedures [11]. This study shall demonstrate how healthcare organizations can use these technologies to improve efficiency, save costs, and better patient care through case studies and real-world implementations [12]. Integration of RPA, NLP, and generative AI into RCM procedures is likely to become necessary rather than optional as the healthcare sector grows [13]. To overcome the drawbacks of conventional RCM and open the door to a more patient-centered and sustainable healthcare system, this research aims to give a thorough understanding of how these technologies can be used [14]. Our goal is to encourage healthcare executives to embrace the revenue cycle management of the future, where automation and artificial intelligence collaborate to provide previously unheard-of levels of efficacy and efficiency.

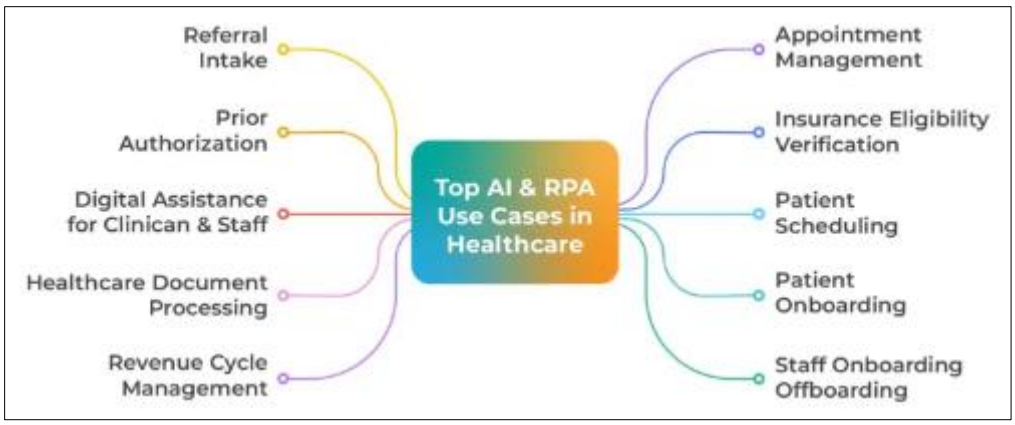

Figure 1 Transforming Healthcare RCM with RPA and Generative AI [15]

1.1. The Role of Technology in Healthcare Evolution

One of the biggest social and economic issues facing any nation is healthcare: administrators, physicians, "researchers, and other field practitioners are under more and more pressure these days due to rising demands from the public and private sectors [16]. Although the quality of people's lives is significantly impacted by the rising expense of medical treatment (particularly more so in the case of chronic diseases), aging and population expansion have an impact on healthcare demands and necessitate the development of new and more sophisticated scientific solutions. Information and communication technologies, fuelled by the growth and success of the Internet, have been crucial in enhancing the accessibility, effectiveness, and quality of any healthcare process since the early 1990s [17]. As a result, the term "e-health," which is generally understood to mean the use of ICTs in healthcare [18], has gained widespread usage. The e-health industry has seen tremendous public interest in recent years, along with previously unheard-of amounts of money and research effort. Although e-health is benefiting from the continuous development of new ICT solutions, the term's precise definition is susceptible to progressive adjustments and specifications due to the vast range of opportunities and problems brought about by the development of ICTs [19]. In the modern world, where all parties are connected through communication, connectivity at any time and from any location is becoming a firm reality for many scenarios. Furthermore, healthcare practices (ubiquitous and pervasive computing) profited from the availability of computing resources at a cheaper cost and a higher integration scale [20]. The remarkable prevalence of wireless and mobile technologies, even among the poorest, provides a sense of the rise of this technology and its promise. Low-cost sensing devices" that can be used for a variety of purposes have become more widely available due to technological advancements and mass market demand [21] (e.g., low-power, miniaturized, non-invasive, and lightweight wireless sensors able to monitor either the functioning of the human body or the surrounding environment and generate large amounts of data) [22]. These conditions also made it possible to apply scale economies by deploying new hardware infrastructures (such as massive data centers that use virtualization technologies) globally and making them available to the general public [23].

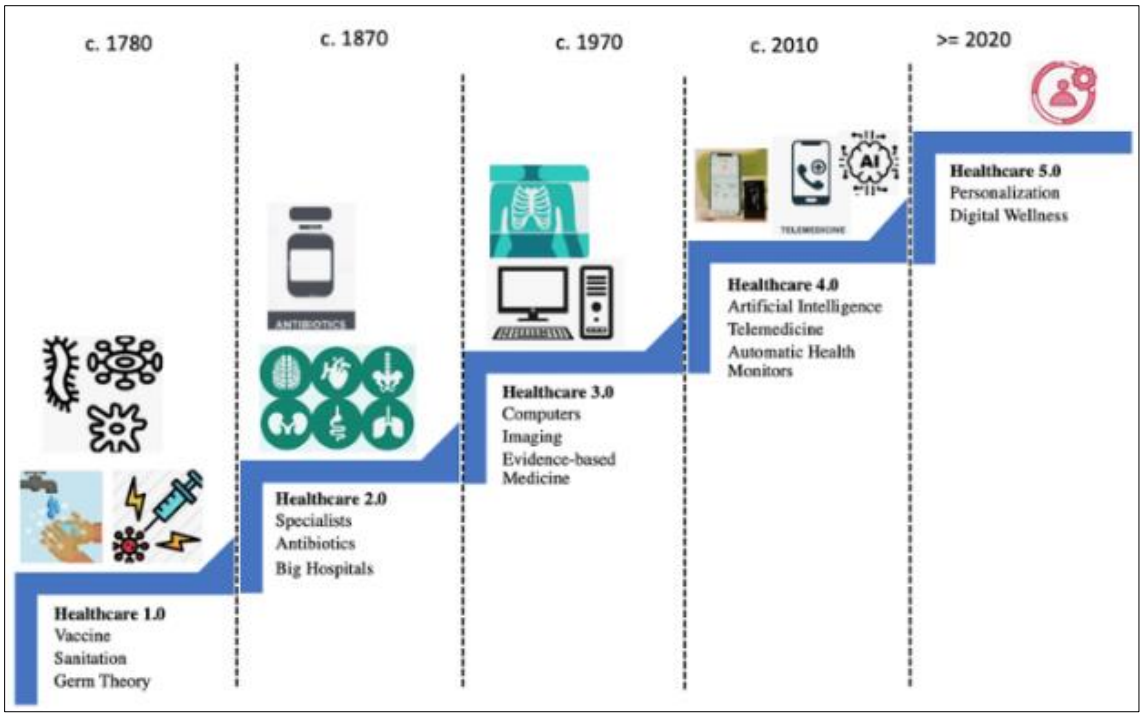

Figure 2 Evolution of Healthcare [24]

1.2. AI and Machine Learning in Healthcare: Driving Innovation

The use of artificial intelligence in healthcare has a lot of promise. Better patient diagnosis, prevention, and treatment, increased cost-effectiveness, and a way to guarantee equitable access to care are all made possible by AI in healthcare [25]. Through the simulation of human intelligence, new information, tools, and concepts are developed [26] using computers (e.g., AI, including machine learning, deep learning, neural networks, and reinforcement learning) that are taught to think and act like people [27]. The healthcare sector needs AI innovation to create creative solutions for healthcare problems and to identify new business prospects. AI has usually been applied for a range of purposes in several disciplines during the last 60 years [28], but its usage in the healthcare sector has not been as successful [29]. Because AI relies on reliable, accurate, "and high-quality e-data to inform algorithm development, this limitation was brought about by a lack of access to e-data [30]. Disparate patient medical databases, like electronic health records, which are used in the healthcare industry, may contain important clinical and administrative information about the patient, including demographics, radiology reports, past medical histories, vital signs, medications, laboratory data, immunizations, progress notes, and insurance information [31]. Numerous healthcare services and administrative procedures for patients, payers, governmental organizations, pharmaceutical companies, and providers could be transformed by AI. This future potential is a result of the field's data sophistication and the increasing availability of electronically" stored patient medical records [32].

AI currently matches or even surpasses human capabilities in speech recognition [34] and autonomous transportation [35] outside of the healthcare industry. Clinical decision support, oncology, psychiatry, surgery, and automatic image analysis of skin cancer are among the healthcare domains where artificial intelligence is currently being used to help [36]. Given the existing problems of limited access to healthcare for everyone [37], a lack of human workers, high service costs, and slow adoption of information technology [38], adopting AI will face challenges in the future in enhancing the quality of the health sector. Researchers have put out three scenarios for the future of AI in healthcare [39]. The first scenario would eliminate the need for doctors by using AI to diagnose every case. The primary rationale for this position is cost savings while preserving comparable patient outcomes. Second, AI may be able to analyze more patients, which would free up clinicians to look at fewer patient cases. Doctors would treat fewer patients as a result, and the healthcare system would save money. Finally, AI might help doctors make better clinical judgments, which would improve patient outcomes and save money.

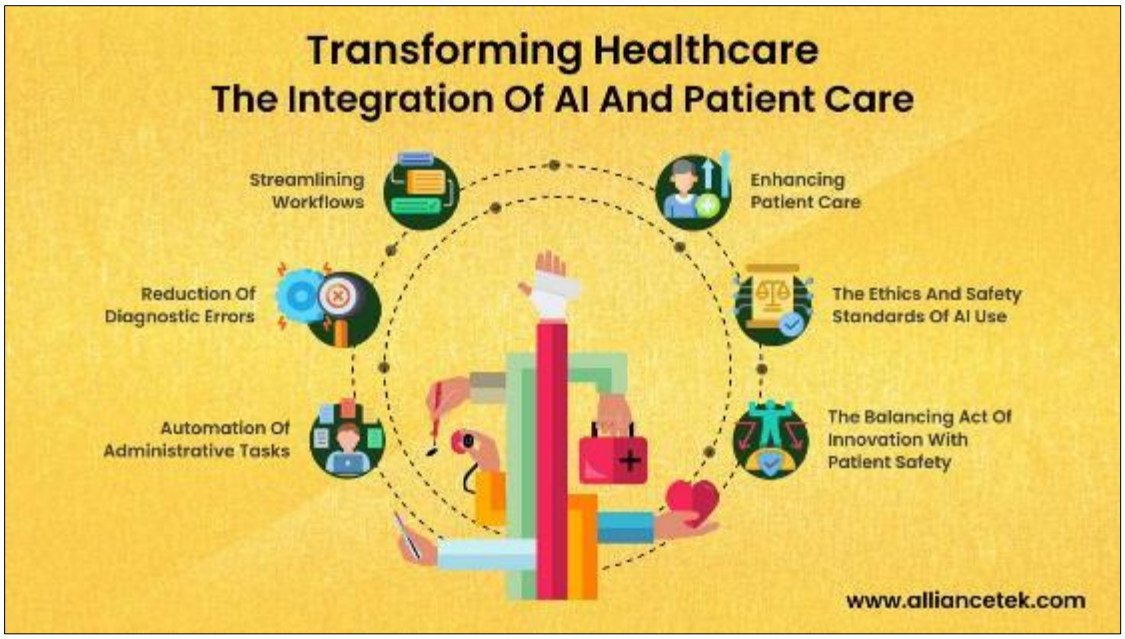

Figure 3 AI Innovations in Healthcare: Transforming Patient Care, Diagnosis, and Administration [33]

1.3. Features and Capabilities of Leading RPA Tools

The use of software robots, or "bots," to automate repetitive, rule-based operations that were previously completed by humans is known as robotic process automation or RPA. Seeking to implement efficiency increases in companies, RPA aims to reduce the demand for human participation, to make it highly accurate, and to accelerate the process.

Among very popular RPA solutions there are, for example, Automation Anywhere, UiPath, and Blue Prism; each of them has its strengths and weaknesses.

Table 1 Features and Capabilities of Leading RPA Tools

RPA Tool	Features	Capabilities	Advantages	Challenges	Use Cases
Automation Anywhere	- Machine learning and AI integration - On-premises and cloud-based solutions - Scalable and user-friendly platform	- Automates complex procedures across multiple systems - Supports businesses of all sizes	- Ease of use - Scalability - Compatibility with various programs	- May require training for advanced features	- Data processing - Workflow automation
UiPath	- Process mining - Analytics - AI capabilities - Attended and unattended automation	- Enterprise-level scalability - Integration with third-party applications - Robust community support	- Full-featured automation toolkit - User-friendly interface - Suitable for large-scale enterprises	- Licensing costs can be high	- Enterprise automation - Customer support
Blue Prism	- Enterprise-class solution - Strong governance and security features - Integration with various platforms	- High-volume and complex automation - Advanced governance and security capabilities	- Suitable for complex automation - Excellent for industries with strict security and compliance requirements	- Steeper learning curve compared to others	- Financial services - Healthcare

Automation Anywhere is a user-friendly platform that incorporates machine learning, artificial intelligence, and RPA. It helps companies automate complex procedures across multiple systems. Because it offers both on-premises and cloud-based solutions, it can be adapted to the needs of businesses of all sizes. The tool has gained wide recognition because of its scalability, ease of use, and compatibility with many programs. Another popular RPA software with a very robust feature set and an easily accessible UI is UiPath. It offers an entire range of automation technologies like process mining, analytics, and artificial intelligence capabilities and supports both attended and unsupervised automation. With robust community support and connectedness to various third-party applications, UiPath is scalable and designed to serve the automation needs of large-scale organizations with high enterprise-level needs. Blue Prism specializes in offering an enterprise-class RPA solution to huge businesses. It is well known for its governance and security capabilities, and companies can automate intricate, high-volume procedures. It will be a good fit for those businesses that have more or broader automation requirements as it integrates very well with other platforms and technologies. Unlike the other tools, it is often thought of as having a more challenging learning curve. Each of these tools has unique advantages, and the choice among them is determined by the specific needs of an organization, which include scalability, usability, and integration capabilities. When used together, these tools are revolutionizing industries by allowing companies to automate processes more effectively and efficiently.

2. Review of Literature

Ghulaxe Vivek, (2024) [40] claimed that Robotic process automation together with machine learning and artificial intelligence enhances conventional automation capabilities, improving business significantly. As a result of this combination, RPA systems can handle complex, unstructured data, make wise decisions, and use learning algorithms to constantly adapt. Customized consumer interaction, higher accuracy, and predictive analytics are some of the outputs of the amalgamation of RPA, AI, and ML. This study examined how this innovative automation approach enhances productivity, scalability, and creativity across various industries, transforming operational processes and establishing a new benchmark for corporate automation.

Afrin Sadia, et al. (2024) [41] stated Digital services and Industry 4.0 have come as the result of very fast technological innovation over the last few hundred decades through the integration of powerful technologies and automation. This review assesses the ideal possibilities of AI-enabled intelligent automation. It hypothesized on the synergistic use of AI with RPA, in improving the enterprise and organizational processes across different industries. RPA automates repetitive, rule-based tasks and alleviates human resources to focus more on creative exercises. The addition of artificial intelligence (AI) features to the RPA will enable it to understand and manipulate data better, including trend analysis, categorization, predictive indication, and the resulting significant increase in accuracy and efficiency. The literature survey presented herein is to assess the current status of the integration of RPA with AI while signifying its application in manufacturing, agriculture, medical operations, finances, and retailing. It also highlights the advantages, and disadvantages, including lowering of costs, faster delivery, and smoother processes, versus limitations and dismissal, including technological challenges and ethical dilemmas. RPA technologies leverage AI techniques, such as classification and text mining using neural networks, to enhance Industry 4.0 and cure the operation of firms.

Subha S, et al. (2024) [42] stated the digital revolution has transcended the biotech and pharmaceutical sectors through the rapid evolution of technology that has opened fresh opportunities in precision-based healthcare and personalized therapy. The research looks at how digital innovation and personalized medicine fit into each other and focuses on the opportunities for transformation in this dynamic field. Artificial intelligence, machine learning, and big data analytics are some of the more advanced technologies in personalized medicine, seeking to adjust therapy and healthcare strategies based on each patient's unique clinical, genetic, and environmental data. With them, a physician may evaluate very large datasets and learn more about how diseases develop and progress in individual patients with the ensuing results in more individualized therapies and improved patient outcomes. Health monitoring reading and encouraging patient interaction have taken wearable technologies and smartphone apps into becoming quintessential components of personalized treatment. Nonetheless, the issues involved include interoperability, data security, and privacy matters; something interesting in personalizing healthcare includes the smooth flow of information exchanges while maintaining patient privacy. For patient safety and data integrity, the regulatory frameworks may have to flex to keep up with the fast pace of technological advances. But equally, there remains a very bright future for digital innovation and personalized medicine in the biotech and pharmaceutical sectors. Healthcare providers have the potential to reinvent the industry by delivering personalized healthcare solutions and revolutionizing the diagnosis, treatment, and management of diseases through strategic investments, teamwork, and a patient-centric approach. In personalized medicine, wearable technology and smartphone apps are essential because they enable ongoing health metrics monitoring and promote patient involvement.

Bhadra Prasenjit, et al. (2023) [43] stated intelligence into the ubiquitous interactions and process automation of enterprise assets, the new developments in cognitive Internet-of-things are upending industrial process automation. Another exciting technological development that is essential to boosting operational excellence across businesses is robotic process automation or RPA. Service workflows that automate repetitive and rule-driven, high-volume tasks are orchestrated by RPA systems. RPA adds automated workflows to the connected enterprise to increase agility and resilience, while the CIoT enables intelligent cyber-physical integration to improve omnipresent operational intelligence. The combination of intelligent RPA and AI-powered IoT is opening the door to game-changing breakthroughs in the Industry 4.0 era, as industrial computing tends to maximize situational awareness and autonomous operations. Beyond complicated decision support and the ubiquitous interconnecting of Industrial IoT, the research explored essential technological components and architectural patterns that offer a new breed of Cognitive enterprise systems that enable intuitive operations and need-based control functions. To convert actionable insight into context-aware process flows, foster interoperability, and carry out prescriptive actions, offer special architectural semantics that bring RPA capabilities within CIoT.

Barla Nilesh Harshit et al. (2023) [44] stated Robotic Process Automation has advanced at an astounding rate in the past year. Its automation of applications has resulted in increased productivity, lower operating expenses, and less time spent on R&D and production. The fourth industrial revolution is being referred to as such as industries that have already included RPA into their workflow and are radically changing into intelligent, automated sectors that require little human participation. Healthcare is far ahead of many other sectors in this race to change. It was resilient against all circumstances and held up well during the fast spread of COVID-19. An unexpected crisis exposed the system's vulnerability, brittleness, and lack of readiness. A new paradigm had to be adopted by the healthcare sector. Despite the economic and human costs, discovered how to change as a community to address this challenge. This research examined what the fourth industrial revolution in healthcare might involve, explains the role of RPA, and explains how these technologies can support healthcare workers in their day-to-day work. The automated, intelligent system would make it easy to collect data in various ways, process it, and help medical professionals provide high-quality care.

Shidaganti Ganeshayya, et al. (2023) [45] stated that the shift from early "Industry 1.0 to current Industry 4.0 can be viewed as a shift from conventional techniques to the current digital procedures. Big data is the collective term for the enormous amounts of data produced by these digital processes, which are said to constitute the cornerstone of Industry 4.0. Even if this helped advance technology, the storage and efficient use of this data, which required unthinkable human labor, was a problem in and of itself. This is where artificial intelligence and robotic process automation come into play. RPA processes automate repetitive work, whereas AI techniques simulate human thought processes. Intelligent automation, which results from the combination of RPA and AI, streamlines human labor while boosting efficiency, productivity, and quality. In addition to these advantages, the efficacy and accuracy of RPA processes in recognition, data extraction, forecasting, classification, and process optimization are enhanced when AI algorithms, strategies, and techniques are combined with RPA tools. This research's primary goal is to provide a quick overview" of the developments leading up to Industry 4.0 and to go over the fundamentals of combining AI and RPA as well as the advantages they offer to humanity. It goes on to clarify some common misconceptions about the two rapidly developing technologies, discuss the difficulties in successfully integrating them, and provide examples of their applications. The research also discussed the different RPA tools in great detail.

Prasad Sandhya, et al. (2023) [46] said that Businesses with inflexible business procedures are at a clear disadvantage in today's more dynamic markets. Even before businesses have the opportunity to rethink their business procedures and make any product changes, customer emotions can shift rapidly. To increase the efficiency and agility of their business processes, many organizations have been moving towards a more flexible, outcome-driven approach. Advanced digital technologies such as robotic process automation, machine learning, and artificial intelligence are being used to revolutionize them. RPA has advanced over the past ten years to the point that it can now be used in extensive enterprise-scale implementations. Even while Intelligent Automation—which combines RPA and AI—is still in its early stages, it has the potential to revolutionize the industry shortly. The purpose of this research is to examine how AI is being used in business process transformation, as well as the advantages and effects of these technologies and their possible commercial uses. This study employed a case study methodology, analyzing a large number of use cases from the finance, telecom, and IT sectors. The business procedures and the use of intelligent automation will be covered in the study. As a result, it will assist managers from a variety of industries in changing corporate procedures.

Fernandez Javier (2022) [47] stated that diagnostic imaging is essential to contemporary healthcare since it helps with monitoring, treatment planning, and disease identification. However, effective analysis and interpretation are made more difficult by the growing number of medical images. To expedite diagnostic imaging analysis, this research investigated the combination of Deep Learning with Robotic Process Automation. Go over the fundamentals of RPA and

DL, how they are used in healthcare, and how they could work together. In addition, provide case examples and talk about the difficulties and potential paths in using RPA and DL for diagnostic imaging analysis.

Thaler Eliza, et al. (2022|) [48] assessed every time there has been a significant shift in the advancement of society since the Agricultural Revolution, jobs have been replaced and changed. The influence of robotic process automation on healthcare system jobs is examined in this research. RPA is a kind of software robot that performs certain tasks by automating human interaction with digital technology systems, websites, or software applications. The research specifically looked at how tasks within different kinds of healthcare workers' occupations change, which particular jobs are most likely to be replaced, and the important factors healthcare systems take into account when deploying RPA. In addition to examining operations in healthcare systems before, during, and following digital transformation, the study compared five significant healthcare systems in the US that have either used RPA or are in the process of doing so. Using case studies, the study concluded that RPA improves healthcare personnel's employment more than it detracts from them and that individual, rule-based tasks are the most likely to be automated. This is because technology allows healthcare professionals to spend more time with patients and lessens burnout. Hospitals may now provide patients with better quality and more accessible care thanks to RPA's efficiency gains.

Kothandapani Hariharan Pappil (2021) [49] claimed that combining robotic process automation with machine learning in data lakes is a step-by-step method to improve automated model deployment, retraining, and data-driven decision-making. The foundation for advanced analytics is laid by data lakes, which are centralized repositories that make it easier to store unstructured, semi-structured, and structured data on a big scale. Together, RPA and ML can automate tedious tasks, expedite “data processing, and enhance model correctness through continuous learning. The study is about how to fuse RPA and ML within data lakes, along with the technologies, strategies, and architecture necessary. In addition to these benefits, improved decision-making power, cost management policies, and also, most significantly, compliance are researched. Some of the issues and how to manage them in terms of implementation of the use of hybridized strategy in data governance, interoperability of systems, and scalability of machine learning: By underscoring examples from the manufacturing industry, the document brings forward best practices and strategic insights to help other businesses to consummately understand and absorb an alliance that could confer it any competitive edge. The purpose of this report is to identify new areas of research and what further developments could be anticipated in the areas of RPA, ML, and data lakes as far as the real revolutionary effect on a variety of industries is seen: cosmetics, health care, and banking.

Silva Maria, and Ahmed Al-Mansouri (2021) [50] Reported as part of the current healthcare framework radiological diagnostics are of significance for the diagnosis, characterization, and treatment of diverse diseases. Some huge transformations are happening in the field of radiological diagnostics with the advent of deep learning and robotic process automation technologies. This research investigated how RPA and deep learning may work together to transform radiological diagnoses. This research investigated the use of RPA in automating workflow procedures and administrative duties in radiology departments by conducting a thorough literature review. It also discusses the promise of deep learning algorithms for decision support, image analysis, and interpretation. Combining RPA and deep learning technology could provide a way to increase the efficiency, accuracy, and productivity of radiological diagnostics. The impact of this synergy on outcomes for patients, the workflow of radiologists, and clinical practice is analyzed. Finally, challenges and prospects of robust use of RPA and deep learning in radiological diagnosis are discussed.

Anagnoste Sorin, et al. (2021) [51] Reported by the use of the cloud, on-premise, or hybrid automation, companies are migrating their work to software robots, changing traditional business models, reducing labor costs, and creating jobs that are better suited for human members. Along these lines, messaging platforms are now dominant as the global communication medium of choice. Furthermore, with the rise of self-service demands from clients, it is now possible for businesses to create internal and external communication without a new user interface. Contemporary chatbots are impressive means of achieving human-robot interaction, and the market is expected to expand consistently shortly. Chatbots can elude technical jargon and vagaries in language due to the technologies that provide their basis, which can identify the intention and process the natural language. Furthermore, chatbots can be integrated with RPA robots and other systems, and integrated into mainstream messaging applications such as Messenger, WhatsApp, Slack, and Viber. Chatbots can initiate conversations, elicit visitor profiles and individualized responses, be "characterized", learn spontaneously, or transfer to a human operator with no difficulty. Time is money and chatbots can perform many of the tasks within the span of less than a second, thus reducing cost and increasing customer happiness internally and externally.

Thorp H. Holden (2020) [52] stated humanity is currently living through a period of profound change. Technological change is accelerating more quickly than in the past. A year's worth of technological advancements surpass the changes made over decades. Customer expectations are rising northward and getting higher every day as a result of technology

improvements. Consumers demand high-quality service that is delivered faster without costing more. Manufacturers and service providers are looking for ways to save costs and enhance quality by reducing flaws, and they are placing large bets on technology to do it. This had traditionally been accomplished through automation. Historically, the focus of technology has been on mechanical robot automation. Robots have replaced complete shop floor and warehousing tasks. Robots are now moving into offices to carry out dull, everyday tasks to complete business transactions. It is referred to as Software Robotic Process Automation in everyday speech. The transformation technology platform that is changing how businesses operate is discussed in the article. From customer-facing tasks to financial backroom operations, from purchasing to manufacturing processes, and from planning to data maintenance, RPA can have an impact on every facet of the company. Many businesses that deal with repetitive, rule-based tasks carried out by system users across IT platforms using both structured and unstructured data stand to gain a great deal from RPA. It frees up people to concentrate more on worthwhile pursuits that call for intelligence, judgment, and conjecture.

Andrade David (2020) [53] stated Robotic Process Automation and its application to contemporary software testing were the subjects of this study's investigation. The purpose of the comparative analysis was to identify the features offered by Automation Anywhere and UiPath, two of the top RPA businesses. Examining current software testing issues, RPA use, and how RPA is being used to address important problems that manual software testing is unable to handle were the goals of this study. Using software scripts that mimic the process or jobs inside a workflow, generally referred to as "bots" or "robots," RPA may significantly automate human tasks by simulating the identical steps that a human would take, mostly through user interface interactions [1]. Through automation of mundane tasks and faster output than what a human software tester achieves, bots can translate into cost reduction and increased service lifetime. Wherever the complexity of business software administration, performances, and processes, RPA is used, there is an enhancement in the same. The study's highlights covered the advantages and disadvantages of RPA based on the capabilities of Automation Anywhere and UiPath when used to address particular software testing problems. The opinions of the authors, case studies, indicators, and other extensive applications were mentioned in the analysis of the data gathered for this study project. Pros and drawbacks, cost savings, and efficient decision-making while choosing automation were all compared. Further investigation is required to enhance RPA software testing of business logic using machine learning and artificial intelligence.

Madakam Somayya, et al. (2019) [54] considered RPA cutting-edge technology. A state-of-the-art in mechanical engineering, information technology, computer science, electronics, and communications is robotic process automation. Used in conjunction with software, networking, and automation, it can handle basic jobs. Google, academic databases, and research databases were consulted for the manuscript's secondary data. Six months passed between January 1, 2018, and June 30, 2018. The infrequent empirical articles, white papers, and blogs published by RPA are cited in this research manuscript. The phenomenon is what marked this study exploratory. Looking through databases, came across RPA, Robots, AI, and Blue Prism. The poll concluded that RPA and robots are rapidly becoming indispensable to the day-to-day running of businesses around the world. Robotic process automation can simplify many administrative tasks, including payroll, onboarding new employees, processing invoices, managing inventory, installing software, migrating data, and accounts receivable and payment. Among the many sectors that make use of RPA are healthcare, pharmaceuticals, outsourcing, retail, telecom, energy and utilities, real estate, fast-moving consumer goods, and many more. RPA is implemented in business processes with the help of several technologies such as AI, ML, DL, data analytics, HR analytics, VR (second life), home automation, blockchain, 4D printing, and many more. Robotic process automation applications from both new and old companies around the world are also discussed.

Heinemann Jan, et al. (2019) [55] stated Companies must monitor a continually expanding and shifting landscape of possible rivals, partners, suppliers, etc. in these days of rapid technological advancement and disruptive digital change. Transparency and discussion regarding industry change at any business level are made possible by the radar technology and methodology, which provide an easy-to-use and intuitive foresight mechanism for a complete organization. To enable end-to-end value from identification and deduction to strategic actions, this strategy must also be fully integrated into the organization's innovation and partner management processes. To delve deeper into the specifics of a trend radar, use artificial intelligence as an example trend category. List key success elements and advantages for businesses that use this strategy.

Table 2 Approach to Literature Reviews

References	Authors / Year	Techniques Used	Research Gaps	Outcomes
[40]	Ghulaxe Vivek (2024)	Software robots perform repetitive, rule-based activities using RPA. Make invoicing, data entry, and customer service more efficient and reduce errors.	RPA tackles organized, rule-based processes, AI and ML for emails, PDFs, and social media are new. RPA, AI, and ML may need further research to evaluate and extract useful data from unstructured data.	RPA with AI and ML automates complex activities and adapts to changing conditions, enhancing efficiency, scalability, and decision-making. Across sectors, predictive analytics, accuracy, and personalized consumer interactions improve.
[41]	Afrin Sadia, et al. (2024)	RPA and AI data analysis, trend identification, categorization, and neural networks improve productivity, accuracy, and business processes. Text mining and classification using AI simplify Industry 4.0.	Scale and customize AI and RPA integration across sectors with variable technology maturity. More research is needed on the ethics and long-term feasibility of this integration in real-world situations.	RPA and AI boost industry productivity, accuracy, and efficiency, enabling creative jobs. It lists technology, morality, and benefits including lower pricing, higher output, and simpler operations.
[42]	Subha S, et al. (2024)	AI, ML, big data analytics, wearable tech, smartphone apps, interoperability solutions, and data security for personalized medicine and precision-based healthcare.	The difficulties of data security, privacy, and interoperability while making sure that legal frameworks change to facilitate the use of cutting-edge digital technology in personalized medicine.	Despite data security and regulatory issues, digital innovation in personalized medicine can revolutionize healthcare by enhancing treatment precision, patient outcomes, and disease management.
[43]	Bhadra Prasenjit, et al. (2023)	Cognitive IoT, RPA, AI-powered IoT, situational awareness, autonomous operations, and architectural semantics for Industry 4.0 context-aware process flows and interoperability.	To promote interoperability, context-aware decision-making, and autonomous operations across industrial environments, research must readily integrate RPA capabilities into CIoT systems.	Intelligent RPA and AI-powered IoT in Industry 4.0 boost operational intelligence, situational awareness, and autonomous decision-making for process automation and agility.
[44]	Barla Nilesh Harshit, et al. (2023)	Intelligent automation, data collection and processing, RPA, and AI-driven technologies to improve healthcare operations and help providers provide high-quality treatment.	Research is needed to fully integrate RPA into healthcare systems to address vulnerabilities, improve resilience, and prepare for emergencies while providing quality patient care.	Intelligent automation and RPA can speed up data processing and collecting and help healthcare providers provide high-quality care, especially during the COVID-19 pandemic.
[45]	Shidaganti Ganeshayya, et al. (2023)	It covers RPA, AI, intelligent automation, data extraction, forecasting, categorization, process optimization, and AI algorithms paired with RPA technologies to improve Industry 4.0 efficiency and accuracy.	The challenges and best practices for merging AI and RPA in Industry 4.0, notably for data consumption and storage and application automation.	AI and RPA in Industry 4.0 eliminate repetitive tasks, increase data extraction, forecasting, and process optimization, and overcome misconceptions and integration issues to boost efficiency, productivity, and quality.
[46]	Prasad Sandhya,	Intelligent automation, case study analysis, RPA, AI, and	The challenges and best practices for deploying	AI and RPA in business process transformation can improve

	et al. (2023)	ML may transform corporate operations and boost productivity and agility across industries.	intelligent automation (AI and RPA) in various industries, particularly for seamless integration and enterprise-level business process change.	productivity, agility, and flexibility for banking, telecom, and IT organizations and assist managers optimize procedures.
[50]	Silva Maria, and Ahmed Al-Mansouri (2021)	Radiological diagnostics workflow automation, decision aid, image analysis, and interpretation using deep learning and RPA.	RPA and deep learning integration issues, future directions, and synergistic effects on patient outcomes and clinical workflows in radiology.	RPA with deep learning can improve radiological diagnostic productivity, accuracy, and efficiency, improving patient outcomes, radiologists' workflows, and clinical procedures.

3. Research Gap

- Limited integration of AI, ML, and RPA technologies into unified healthcare systems, resulting in fragmented digital transformation efforts.
- Inadequate scalability of existing solutions to handle complex healthcare workflows and data interoperability challenges.
- Lack of comprehensive frameworks for leveraging AI and ML models to optimize real-time decision-making in patient care.
- Insufficient studies focusing on how RPA can effectively reduce administrative burdens while ensuring compliance with healthcare regulations.

4. Research Objective

- To analyze existing frameworks and methodologies for digital transformation in healthcare, with a focus on the integration of AI, ML, and RPA technologies.
- To enhance interoperability and data sharing between healthcare systems to improve patient outcomes and operational efficiency.
- To review advancements in AI-driven models for predictive analytics and personalized treatment, highlighting their potential to address diverse medical conditions.
- To investigate RPA's role in automating repetitive tasks, such as billing and patient data management, to optimize resources and improve service delivery.

5. Result Layout

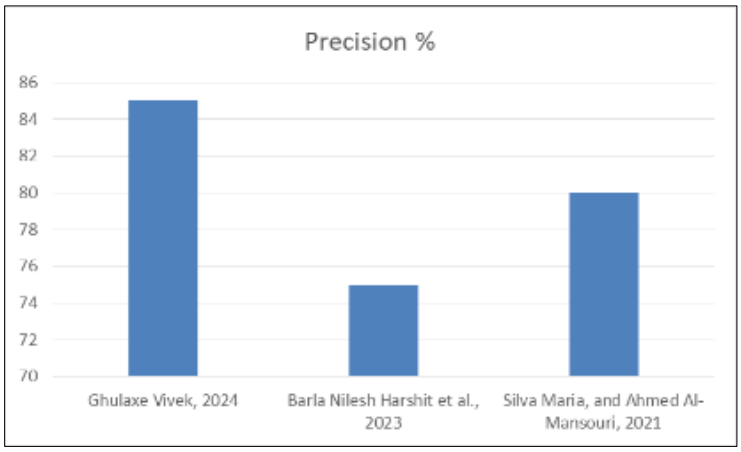

Figure 4 Precision Comparison Analysis

The graph (fig. 4) shows how various studies on robotic process automation (RPA) compared in terms of precision. Based on the best RPA application with a low number of errors, Ghulaxe Vivek (2024) achieved an RPA implementation

with (an 85% precision score. In their close second with a 75% accuracy, Barla Nilesh Harshit et al. (2023) show strong but marginally inferior performance. (Silva Maria and Ahmed Al-Mansouri (2021) achieve an 80% accuracy rate, as it shows a robust approach, with the power of RPA and deep learning technologies. Although the experiments of Ghulaxe Vivek outscore for their highest accuracy [1], the research studies of Barla Nilesh Harshit et al. And Silva Maria, with slightly reduced, but still significant, precision scores, provides valuable clues in the direction of the future of RPA.

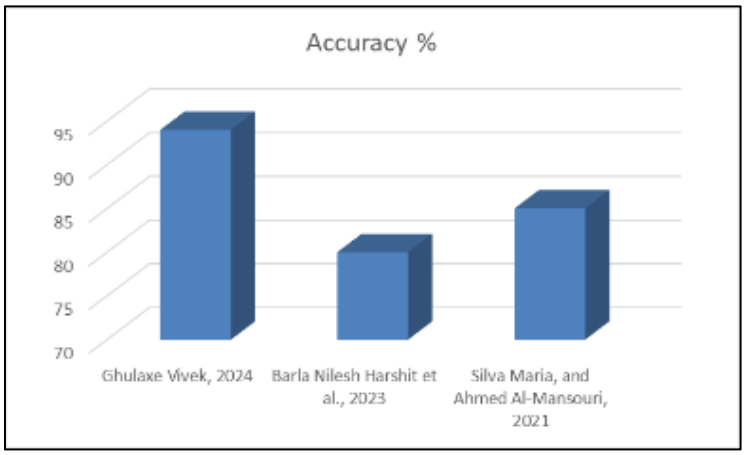

Figure 5 Accuracy Comparison Analysis

The accuracy curve presented in Figure 5 describes how many studies in RPA research have differed in the level of precision. The RPA installation that is the most reliable and accurate so far, with minimal errors and great outcomes, is reported by Ghulaxe Vivek (2024) at an accuracy rate of 94%. In a very similar study, Silva Maria and Ahmed Al-Mansouri (2021) demonstrated an excellent potential to exploit RPA but they achieved much lower accuracy in comparison to Vivek's work (85%. Although less specific than the other two studies, Barla Nilesh Harshit et al. (2023) still demonstrated the effectiveness of RPA with 80% correct accuracy. The graph very obviously indicates that Ghulaxe Vivek has the highest accuracy. On the other hand, Silva Maria, Ahmed Al-Mansouri, Barla Nilesh Harshit, etc., and so on, provide valuable information on what RPA can do and they all play a role in a good outcome, but some more than others.

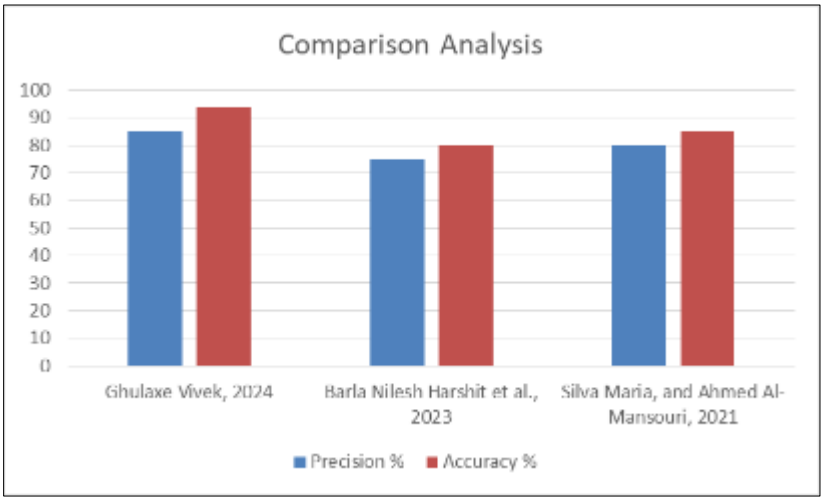

Figure 6 Comparison Analysis

Figure 6 illustrates a comparison analysis of research studies' Precision and Accuracy metrics regarding robotic process automation (RPA) and its related technologies. When precision (85% and accuracy (94%, respectively, are greatest in Ghulaxe Vivek (2024), it indicates a high utility of RPA in business process optimization with minimal errors and highly accurate results. In the wake of Vivek's work, Barla Nilesh Harshit et al. (2023) show robustness but slightly worse performance (precision=75% and accuracy=80%. Silva Maria and Ahmed Al-Mansouri (2021) as a balanced perspective demonstrate that the RPA and deep learning-based radiological diagnoses are good, though marginally less effective

overall, achieving 80% precision and 85% accuracy. The data reveals that these studies are generally accurate and precise, but show small variability as a function of the industry the RPA is being used in and its level of sophistication.

6. Conclusion

The review highlights the transformative impact of the use of AI, ML, and RPA technology in many domains, in particular, in the healthcare field. The findings demonstrate how these technologies can foster efficiency, accuracy, and creativity by automating tedious work and simplifying complex workflows. Across the analyzed experiments, Ghulaxe Vivek (2024) demonstrated the greatest precision and accuracy in the implementation of RPA, suggesting the RPA capability of producing minimal errors and excellent results. Similarly, studies by Silva Maria and Ahmed Al-Mansouri (2021) and Barla Nilesh Harshit et al. (2023) described the usefulness of intelligent automation in improving productivity, decision-making, and operational efficiency but with small differences in terms of sensitivity and accuracy metrics. These results corroborate the growing importance of RPA on issues of scalability, accuracy, and personalization in health care at large.

However, significant research gaps remain in areas, including seamless combination of AI, ML, and RPA technology, interoperability problems, and scalability for handling complex processes. The lack of generally applicable frameworks for real-time decision-making and compliance monitoring in the (medical) field of application raises the need for clearly defined research initiatives. Correcting these shortfalls can lead to the development of unified, elastic systems that benefit patients, reduce administrative overhead, and enable ethical and responsible digital transformation. With more organizations adopting novel technology, a sustainable balance between innovation, regulatory compliance, and long-term sustainability will be key to realizing their true potential.

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