

A survey of AI-based robotic process automation for businesses and organizations

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ABSTRACT

This paper explores the theories and practical applications of AI, AI-based RPA and RPA in enterprises as well as in organizations. Recent advanced and modern techniques of AI, AI-based RPA and RPA are also presented and discussed in this study. In addition, this study also presents individual and combined solutions in applying AI-based RPA for small-cap companies to leading and multinational companies. Research results show that AI-based RPA technology has very good applications to replace human activities in many different fields and industries, such as economics, administration, business, banking, marketing, and medical care.

Key words: AI, RPA, AI-based RPA, robotic process automation, business process

INTRODUCTION

Autonomous Research recently released a report estimating that in the US alone, nearly 3 million financial services workers will use AI technologies in the office – more than a million in banking, and lending, more than half a million people work in the field of investment management, and more than 800,000 people participate in the insurance sector¹. Robotic process automation (RPA) supports the automatic execution of steps according to normal rules or process chains based on structured data using programmed software robots, and RPA also includes automated recurring operations at preset times². RPA systems will perform the majority of rule-based tasks. Under ideal circumstances, the repetitive tasks involved would be fully automated. The robot automatically monitors financial transactions, executes stock trades, selects potential candidates, promotes products and recommendations, and recommends what you should see on the Web or on other websites. media channel³. The study⁴ also presents a wealth of detailed material for those planning to prepare to implement workflow automation. According to⁵, Americans invested more than \$1 billion in AI-related technologies in 2015; the countries of the European Union have bolstered Europe's robotics industry with more than \$500 million in public funding. In addition, more than 100 educational units at Chinese universities research and practice automation, while nearly 50 UK universities are training in AI. Investment in AI technology is also very active in private companies, with more

than 80 AI-enabled funds being deployed. According to⁶, more than 50% of HR staff are considered clerical staff. Over time, much of their work will be automated and accomplished by a combination of new techniques such as RPA, AI, virtual assistants, and application software development.

BACKGROUND

RPA and AI

RPA “is the use of a software robot or ‘bot’ that replicates the actions of a human to execute tasks across multiple computer systems. According to the professional services organization Deloitte, a minute of work for a robot is equal to approximately 15 minutes of work for a human”⁷. Additionally, bots can work 24/7, increasing productivity even further. According to⁸, RPA-based robots are used in place of humans to automatically collect data, automate data entry, and analyze data in various applications. A combination of workflow, business rules and ‘presentation layer’ integration with information systems to act as a semi-intelligent user of the systems⁹. What makes big data so valuable is the development of information retrieval and collection technologies to generate benefits, including IoT, machine learning¹⁰, RPA and AI, which enable data mining and use at various levels. These technologies enable the use and application of big data in a wide range of agricultural and commodity sector activities, manufacturing and services. One of the disadvantages of AI-based RPA in production is that it highlights potential operational risks

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from adopting AI-based systems such as RPA¹¹. They make the point that incomplete models of training can reduce work efficiency and introduce many errors due to unwise or even wrong decisions.

Challenges of AI-based RPA in the production process: The purpose of the work¹² is to outline the inevitable difficulties companies will face and provide guidance on the preparatory steps to take before the second version of robotics technology can be deployed on a large scale.

RECENT TECHNIQUES FOR AI-BASED RPA

Typical suppliers offered RPA solutions include Automation Anywhere, Blue Prism, UiPath, WorkFusion and Advanced Systems Concepts.¹³ pointed out that RPA has many advantages, features and applications, such as automatically solving cumbersome problems in human resources and automatically handling very large amounts of data. Recent popular platforms supporting RPA technology include Power Automate, Pega, WorkFusion, Jacada, WinAutomation, NICE system, Automation Anywhere, Blue Prism and UiPath, and RPA can be deployed to automate tasks. Furthermore, this paper also shows the advantages and limitations of RPA technology and related machine learning technology. Xchange has had the advantage of being efficient in processing time thanks to its robotic operating model (ROM) and enterprise RPA model. Companies already benefiting from this technology include Barclays Bank, Shop Direct, npower, NHS and Telefonica/O2.⁴ Blue Prism ROM is well developed in building a solid foundation for the future in automation technology. Tech Mahindra introduced an automation platform called AQT (Automation, Quality, Timing), which is capable of predictive analytics, machine learning, autonomous, RPA and natural language processing¹⁴. This helps increase business efficiency and stakeholder efficiency through the unification of platforms, tools, and automation platforms. AQT uses RPA to facilitate faster delivery and save staff time and effort. Tech Mahindra's AQT Automation Framework includes the Automation Technology Center (CAT), SureSmart - the Automation Thinking and Automation platform and tools. The product supports machine learning QAT (Automation, Quality, Timing). Tech Mahindra (India) company drives smart automation use cases by using technologies that integrate RPA (robotic process automation) to capture, machine learning, and machine learning. Predictive analytics to meet customer needs. In addition, AQT makes Mahindra's

value chain efficient, as it positively impacts process, quality, user experience, time-to-market and delivery costs¹⁵. While supply chain and, in particular, procurement functions are traditionally considered "conservative and operational", recent examples such as Chain IQ¹⁶, operating as innovation front-runners, contradict this traditional viewpoint as they are applying: (i) Cognitive computing solutions for its e-Auction sourcing process, (ii) AI-supported RPA (robotic process automation) solutions to replace its thus far manually supported sourcing operations.

AI-based RPA for natural language processing

Artificial intelligence (AI), robotic process automation (RPA), machine learning and natural language processing (NLP) have shown potential for sustainable development¹⁷. Categorically, there are two "types" of chatbots¹⁸. One is rules-driven, and the other is driven by machine learning and artificial intelligence (though rules also play a large part in these). According to¹⁹, the application of technology allows humans to configure computer software, aka "robots" ("bots"), to capture and interpret existing applications. Artificial intelligence technologies thrive in applications such as games²⁰. The same is true for work situations in the interaction of humans and robots. The paper²¹ proposed to develop an artifact, a process parameter metric, which will indicate the process suitability for AI-based automation and possibly extend the ITIL (Information Technology Infrastructure Library) framework.

AI-based RPA for businesses and organizations

According to¹⁴, RPA helps to gather information from data sources efficiently. Manual jobs will be eliminated to save manpower, cost and time. RPA and ML are necessary to reap the full benefits of AI. The process for implementing "AI-based RPA (Robotic Process Automation) for businesses and organizations" includes the following steps (see Figure 1:

Needs analysis and goal definition:

Conduct a technical and functional analysis to identify specific processes that need to be automated. Define specific goals that firms want to achieve through RPA.

Select RPA and AI Technologies:

Choose RPA and AI technologies that align with the requirements of each company. This includes select-

ing the RPA platform, automation tools, and AI technologies such as machine learning and natural language processing.

Data Gathering: Collect data from systems and data sources necessary for training AI models if needed.

Development and AI Model Training: Build and train AI models to automate tasks within the workflow.

RPA and AI Deployment: Deploy RPA and AI solutions into the production environment. This may involve integration with existing enterprise systems.

Testing and Adjustment: Fine-tune AI models and RPA processes over time to improve performance and accuracy.

Monitoring and Management: Manage and maintain RPA and AI solutions over time to ensure that they continue to operate effectively.

Staff Training: Train employees on how to use the new RPA and AI tools and processes so they can make the most of the technology.

Optimization and Scaling: Consider optimizing and expanding the application of RPA and AI to other areas and workflows within the organization.

Assessment and Reassessment: Evaluate and reassess the results and benefits achieved from the RPA and AI deployment to determine if it meets the initial goals and requirements.

To fully appreciate the potential value derived from technology, rather than hastily embracing AI implementation, it is imperative to comprehend its operational mechanisms²². One instance of this involves a consultant utilizing RPA software, specifically EnableSoft's Foxtrot (1). Additionally, an innovative approach emphasizing the human-centric development of software robots and incorporating high-level RPA and DSLs for efficient robot control has been proposed²³. This approach has been adopted by Her Majesty's Revenue and Customs in England for their Robotic Process Automation (RPA) initiative, where AI complements specific tasks while human oversight remains²⁴.

A significant player in the AI domain is IBM, which has invested over \$1 billion in AI technology through the Watson Group. This renowned healthcare company deploys AI applications for medical recommendations.

Furthermore, interactions between customers, insurers, and supply chains can be streamlined and automated, simplifying processes. RPA can significantly alleviate challenges faced by complaint handlers. AI is also instrumental in identifying fraudulent customer behaviors that were previously challenging to detect and in analyzing social networks to assess the risk levels of customers for fraud²⁵.

An investigation into the legal and ethical aspects of robots and robotic application systems is explored in a research study²⁶. It delves into crucial legal and ethical concerns related to robots, particularly their impact on various areas of legal practice. Additionally, collaboration between the National Investigation Agency (NIA) in India and Infosys, a prominent multinational IT company, has resulted in an automated solution for provisioning and deprovisioning access rights, alongside automated data synchronization for business entities¹⁵.

A literature review-based paper outlines the pivotal role of AI in digital transformation²⁷. It begins by discussing key AI features and technological aspects crucial for digital transformation, followed by an extensive assessment of AI's widespread advantages. The paper²⁸ investigates current trends in different learning strategies and methods, particularly those related to robot control using simulation learning, deep reinforcement learning, computer vision, and their potential applications in manufacturing. It also addresses their limitations, advantages, and open challenges.

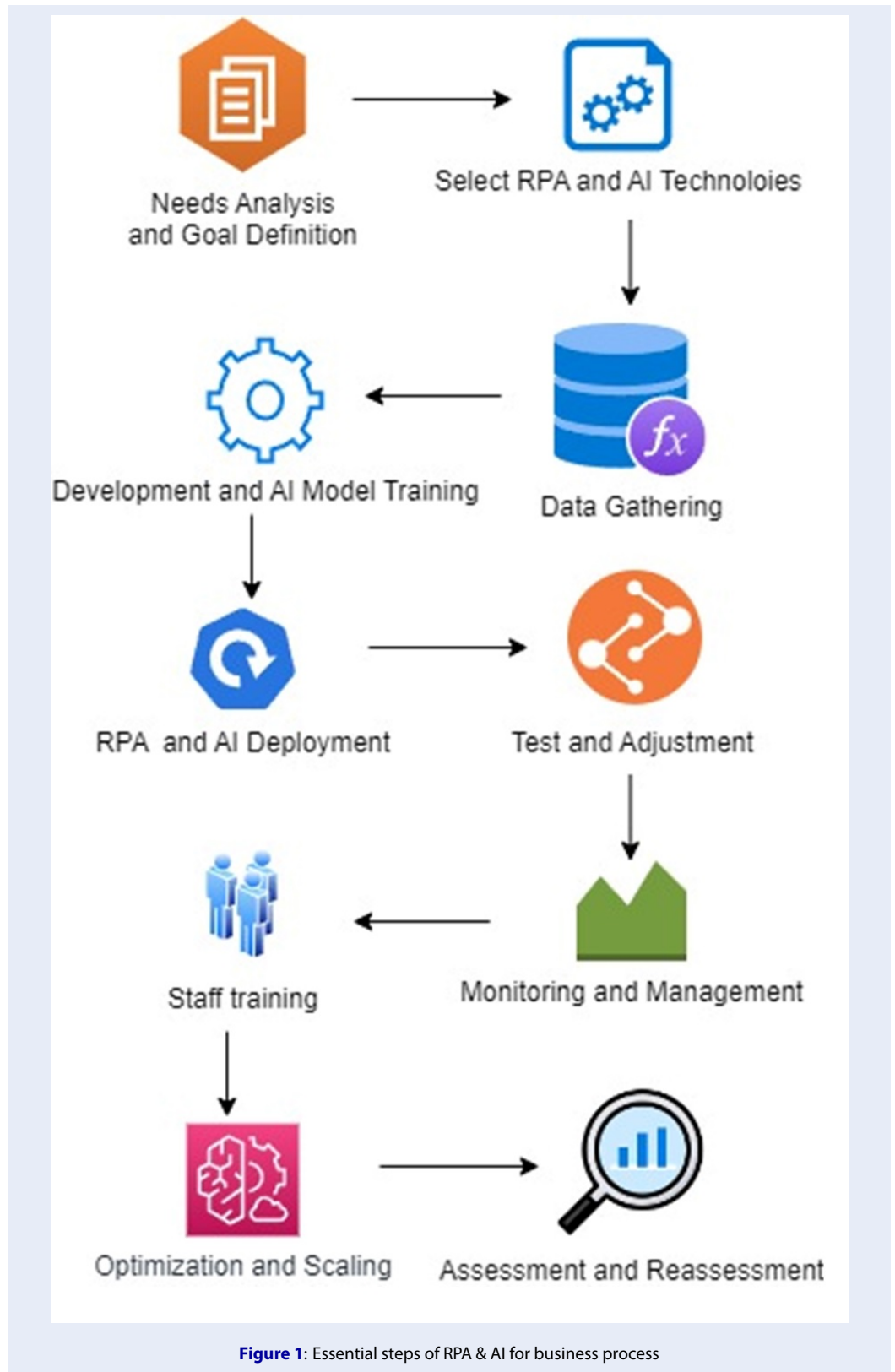
Another paper²⁹ explores AI-based assistance systems for robots and advocates for the use of value-sensitive design (VSD) as a suitable framework for designing these technologies with a focus on human values. Meanwhile, a different paper³⁰ proposes a comprehensive survey of AI-based models that professionals can reference in real-world contexts.

In a research paper³¹, data from Flipkart and Amazon, including product names, prices, review scores, and product ratings, are processed using Robotic Process Automation (RPA) and preprocessed according to user requests for product information. The paper further outlines the recommendation of products on these e-commerce platforms based on user preferences.

Another study³² employs robotic process automation (RPA) and artificial intelligence (AI) techniques to enhance email handling. This robotic software system streamlines tasks such as email categorization, attachment management, and spam filtering, thereby improving system performance.

The study³³ underscores that AI is not a standalone technology but rather a combination of various information system configurations throughout a company, dependent on multiple factors such as data, processes, rules, key decisions, and external partnerships.

A significant development in the manufacturing sector is the introduction of Bot-X, an AI-based virtual assistant designed to handle complex tasks such as order processing and manufacturing operations³⁴. This



study comprehensively examines Bot-X's design dynamics, architectures, algorithms, and responsiveness in a manufacturing context.

Furthermore, intelligent automation, its internal structure, evolution, and relevance in practical applications, especially in Industry 4.0, are discussed³⁵. The paper³⁶ showcases the application of IQ Bot for document classification, extraction, and validation using techniques such as computer vision, machine learning, and text classification, particularly for processing invoices and documents.

The use of UiPath in implementing a clothing and weather recommendation system is explored in another paper³⁷. This project focuses on automating data collection from the internet and providing real-time weather information and clothing recommendations based on weather conditions.

The paper³⁸ delves into the application of AI-based RPA technology in business processes, emphasizing task coordination between users and computer systems. Meanwhile, a study³⁹ discusses the need for an AI-based robotic system founded on deep learning, artificial intelligence, and computer vision to address existing treatment system inefficiencies.

Intelligent transportation systems and the application of AI in the transportation sector are the focal points of another paper³⁹. It addresses challenges and solutions in various subsystems, such as traffic management, public transport, safety management, and production and logistics within intelligent transport systems.

Papers^{28,40} present methodologies for systematically constructing classifiers for cognitive RPA components and analyzing features in real-world scenarios. Additionally, a paper⁴¹ introduces a method for manual robot fabrication using AI models, addressing challenges such as insufficient training data, data bias, interpretability, and security.

A paper⁴² proposes enhanced RPA through a systematic mapping study (SMS), identifying and analyzing nearly 65 publications to provide insights into RPA activities. This study suggests avenues for developing more complex RPA structures.

Furthermore, the paper⁴³ demonstrates how Deutsche Bank successfully employs AI-based RPA to automate adverse media screening (AMS), increasing search levels and reducing inaccuracies.

Finally, a paper⁴⁴ introduces a method for testing software with RPA automatically, making RPA software more adaptable and reducing human involvement in support processes. It also highlights platforms such as Power Automate, Pega, WorkFusion, Jacada, WinAutomation, NICE Systems, Automation

Anywhere, Blue Prism, and UiPath for implementing RPA in various tasks. Additionally, paper¹³ discusses the pros, cons, and applications of RPA and the machine learning approaches used in RPA processes. A unique approach to efficiency and product quality management is presented in paper⁴⁴, which integrates control and robot capabilities with user operational flexibility, fostering a dynamic and secure solution that significantly reduces time and costs and increases work efficiency.

Finally, paper⁴⁵ presents solutions for three major companies in the oil and gas, pharmaceutical, and paint sectors, orienting them for future use. It utilizes survey questionnaires sent to SAP customers about their interface design and prototype interface development to derive insights.

The paper⁴⁶ describes a method for software test automation with RPA, increasing RPA software flexibility and reducing human involvement in support processes.

Moreover, the study⁴⁷ showcases how Romanian farmers are involved in a project that leverages innovative cattle farming methods, incorporating AI-based RPA and IoT.

Artificially intelligent tools such as ChatGPT, capable of generating human-like text, find applications in diverse contexts but come with ethical and legal challenges. This article⁴⁸ compiles insights from nearly 45 experts spanning various fields, suggesting potential benefits in industries such as banking, hospitality, and IT but raising concerns about privacy, biases, and misuse. It calls for further research in areas such as AI knowledge, transparency, ethics, digital transformation, and effective human-AI collaboration to address these challenges and opportunities.⁴⁹ Study highlights the potential of ChatGPT to enhance customer service, automate business processes, and reduce operational costs for enterprises. However, it also emphasizes limitations such as the need for specific training data and the potential for bias in AI responses. Businesses should carefully consider these factors before deploying ChatGPT and implement appropriate security measures to prevent misuse. Additionally, utilizing DeLone and McLean's Information Systems Success model,⁵⁰ found that ChatGPT's system quality, information quality, and service quality positively influence user satisfaction and benefits, with service quality having the most significant impact. Thus, AI tools such as ChatGPT hold wide-ranging applications but also face ethical and legal challenges. In addition, ChatGPT shows potential in

improving customer service and streamlining business processes, but limitations and security measures must be carefully considered.

The mentioned ideas showcase a multitude of studies, applications, and deployments of RPA and AI technology across various domains. From utilizing RPA and AI to address challenges in the manufacturing industry to streamlining processes in the finance and customer service sectors, these studies demonstrate that this technology has the potential to reshape how we work and provide added value across diverse fields. In addition, we observe that RPA and AI not only automate basic tasks but can also be applied to develop complex solutions, such as handling unstructured information, document classification, and even creating intelligent virtual assistants. Therefore, these research findings and applications highlight the potential and effectiveness of RPA and AI in various domains, raising questions about how we can harness this technology to maximize performance and innovation within our organizations and businesses.

CONCLUSION AND FUTURE WORK

The study presented important theoretical foundations of RPA, AI and AI-based RPA-related software used in different companies around the world. In addition, the research also shows significant benefits in applying science and technology, especially AI-based RPA solutions in digital transformation processes and manual and labor-intensive operations. replaced by automation solutions. The paper also points out some potential opportunities and challenges in researching and implementing AI-based RPA for enterprises as well as in organizations.

The convergence of artificial intelligence (AI) and robotic process automation (RPA) is reshaping business processes and yielding substantial benefits. Key advantages include enhanced operational efficiency through task automation, cost reduction, and the ability to allocate human resources to higher-value tasks. Furthermore, AI and RPA empower data-driven decision-making, enabling organizations to glean valuable insights and stay ahead in dynamic markets. As businesses continue to embrace AI and RPA technologies, they unlock opportunities to optimize processes, reduce costs, and remain competitive in an ever-evolving business landscape. This transformative partnership holds the promise of revolutionizing how companies operate and adapt to future challenges.

In the future, we plan to conduct more in-depth research on AI-based RPA on Big Data platforms to propose better solutions applied in automating support processes for businesses and organizations. We will also focus on refining AI algorithms to enhance decision-making capabilities and expanding RPA capabilities to tackle increasingly complex tasks. Additionally, efforts should be directed toward improving human-AI/RPA collaboration interfaces, ensuring seamless integration into existing workflows. Furthermore, exploring AI-driven predictive analytics and real-time data processing for more proactive decision support is a promising avenue. The integration of AI-driven chatbots and virtual assistants can also be explored to enhance customer interactions and streamline user experiences. Continuous innovation and adaptation will be key to maximizing the potential of AI and RPA in business processes.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

NOMENCLATURE

AI: Artificial Intelligent

IoT: Internet of Things

AMS: Adverse Media Screening

AQT: Automation, Quality, Timing

NICE: Neptune Intelligence Computer Engineering

RPA: Robotic Processing Automation

SMS: Systematic Mapping Study

VSD: Value-Sensitive Design

AUTHOR'S CONTRIBUTION STATEMENT

Thon-Da Nguyen, Su Le-Hoanh, and Nghia Nguyen-The-Dai jointly contributed to surveying and researching related models. Thon-Da Nguyen and Thanh Lam-Hong contributed to the architectural design of the solution, Su Le-Hoanh contributed to the relevant theories, Anh Tran-Thi contributed to finding companies and organizations using RPA, and Than Tran-Quang contributed to finding tools relating to RPA and AI.

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