RPA Technology: Exploratory Research on Robotic Process Automation

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ABSTRACT
This paper presents the results of an exploratory research on Robotic Process Automation (RPA), which seeks to obtain conceptual definitions of this technology, including the definitions of Attended and Unattended Robotic Process Automation and Cognitive Automation. In addition, it will expose the options currently available in the market to carry out automation through RPA and finally proposes a general methodology to carry out automation projects with RPA.

Keywords: Robotic Process Automation, RPA, Attended Automation, Unattended Automation, Cognitive Automation.

1. INTRODUCTION
The invention of the steam engine started what is historically known as The Industrial Revolution. This historical period is divided into different stages, depending on the used energy generation system and on the technological advances that define the way in which products are manufactured. Industrialization of societies begins with the introduction of mechanical manufacturing equipment at the end of the 18th century, when use of machines changes the techniques and production methods, giving rise to an unprecedented economic growth at that time [1].

In the middle of the 20th century, the Second Industrial Revolution emerges, characterized by the division of labour and the use of electricity to achieve mass production. This stage is followed by the Third Industrial Revolution, which begins during the early 1970s and has continued to this day, consisting of the use of electronics, and information and communication technologies to increase automation of manufacturing processes, where not only machines play a fundamental role in production labour, but also participate in decision making processes, leading to the automation of business processes. Finally, the Fourth Industrial Revolution, also known as Digital Revolution, manifests itself through the so-called emerging technologies, which are defining the way we live, work and relate to each others [2] [3].

The colombian Ministry of Information Technologies and Communications expresses that a technology is defined as emerging technology when it causes a radical change in business, industry or society, allowing to respond in different ways to complex problems faced by the current society [4]. Some examples of emerging technologies are Artificial Intelligence, Internet of Things, Cloud Computing, 5G Communication Networks, 3D Printing, Cybersecurity, Data Analytics and Robotics in Process Automation, along with others [3] [5].

This paper offers a conceptual discussion on Robotic Process Automation. It tries to synthesize the relevant definitions in this area, its relationship with Artificial Intelligence and seeks to highlight common mistakes that can be made, and good practices needed when implementing Robotic Automation of Processes projects.

2. LITERATURE REVIEW
The literature review in this research took place between June 2020 and June 2021, and identified relevant sources related to Robotic Process Automation, consisting of academic articles, books, white papers of RPA providers, and online technical websites, including providers websites, blogs of experts and government documents on the matter.

3. ROBOTIC PROCESS AUTOMATION

3.1. History of Robotic Process Automation
Mullakara [6], distinguishes two stages in the Information Technology Revolution that preceded the emergence of Robotic Process Automation: Computerized Automation and Business Process Management.

During Computerized Automation, a period that spans from the 70s to the 90s of the last century, the trend of computerizing business lines of organizations begins. This leads to the appearance of Management Information Systems (MIS) within organizations, inducing them to adopt initiatives focused on administrative processes to improve their business results. This gives rise to the need to reinvent the way of managing business processes.

In the mid-90s, Business Process Management (BPM) comes up as a methodology where multiple techniques are used to support the design, administration, configuration and optimization of business processes, which in a short time contributes to the development of multiple technologies with the ability to automate business processes (BPA).
The BPM methodology and the subsequent development of automation through BPA allow companies such as BluePrism, Automation Anywhere and UiPath to appear, providing products that interact with existing software systems to achieve a new level of automation, capable of cost reducing through the automation of simple repetitive processes. This leads to the first appearances of the term Robotic Process Automation (RPA).

3.2. RPA Definitions

Since its birth in the early 2000s, the definition of Robotic Process Automation has been changing as its ability to adapt to automatable processes advances and also according to the emerging technologies that it can rely on to evolve.

FIS [7] defines Robotic Process Automation as “the use of a computer to create a full-time equivalent (FTE) virtualized resource to manipulate existing software applications in the same way as a person processes a transaction or completes a process”, clarifying that RPA does not replace the existing service provider.

Charles Sutherland [8] describes robotic automation as “the application of specific technology and methodologies to use a computer or “virtualized FTE or robot” rather than a person to manipulate existing application software (e.g., ERPs, claims applications, databases, learning management systems) in the same way that a person today processes a transaction or completes a process”, clarifying that RPA does not replace the existing service provider.

Somayya Madakam [10] defines RPA as “… an emerging form of technology for business process automation, based on the notion of software robots or Artificial Intelligence (AI) workers”.

Finally, the Institute of Electrical and Electronics Engineers IEEE [11] standardized the definition of RPA as: “Preconfigured software instance that uses business rules and a choreography of predefined activities to complete the autonomous execution of a combination of processes, activities, transactions and tasks in one or more unrelated software systems to obtain a result or service with human exception management ”.

As can be seen, the above definitions have three elements in common. First of all, software robots or bots as the fundamental axis behind Robotic Process Automation. On the other hand, they all highlight the bots abilities to interact with existing software systems, without having an inherent integration with them. Finally, they underline the bots lack to handle exceptions in the workflow on which it intervenes.

4. RPA EVOLUTION

Robotic Process Automation has evolved so that today four different categories can be distinguished: Assisted or Supervised RPA; Unattended or Unsupervised RPA; Autonomous RPA; and Cognitive RPA.

The main characteristics of each of the RPA categories are described below.

4.1. Attended RPA (RPA 1.0)

Attended RPA, also known as Supervised RPA, Robotic Desktop Automation (RDA) or Assisted RPA, allows the automation of various activities and applications executed at the workstation level [12] [13]. Supervised RPA has proven effective in reducing average handling times, improving user experience and resulting in cost savings. This also means that long and complex processes were conveniently replaced with mouse clicks, significantly reducing training time for the agent in charge.

However, Supervised RPA should only be used when real-time human-machine interactions are necessary. This means that the robot acts as a human being’s digital assistant, performing certain actions of the process and returning control to the person in the workstation [14].
4.2. Unattended RPA (RPA 2.0)

Also known as Unassisted RPA, this RPA category is usually deployed on servers level, where multiple machines run without requiring the process to be supervised. Here, the automation does not require a person to enter a particular machine (computer or server), authenticate, start the process, validate its behavior and close it when it has finished.

These steps can be automated and can be simplified through dashboards, which provide a window for assigning tasks to machines, setting priorities and queues, and intervening with the behavior of a specific robot when necessary.

With Unattended RPA it is possible to replace human interaction in business processes with a fully automated robot, where bots can be triggered by events and they can be scheduled [15]. However, the unattended RPA bot must be supervised by a human expert, who monitors the execution of processes to ensure that they are successful and to handle exceptions of problems to determine the cause, correct it and restart the bot so that the process resumes where it stopped [14].

Figure 4 shows a simplified architectural comparison between Unattended (left) and Attended (right) RPA. Attended RPA uses isolated and dedicated server environments, usually accessible only for administrators and authorized operators. On the other hand, Attended RPA has robots running within the session the user’s desktop environment.

4.3. Autonomous RPA (RPA 3.0)

Autonomous RPA systems are deployed on the cloud level. This means that RPA systems can be dynamically scalable (implement scalable virtual workers) and allow end-to-end automations.

Although, Autonomous RPA is limited to processing structured data [12]. This means that with this kind of RPA applications, users can automate processes that involves data stored in relational databases and spreadsheets.

4.4. Cognitive RPA (RPA 4.0)

Cognitive RPA, also known as Intelligent Process Automation (IPA), makes use of Artificial Intelligence and other emerging technologies, like Machine Learning and Computer Vision, Natural Language Processing, Data Mining, Semantic Technology, Text Analysis, Machine Learning, etc., for handling processes with both structured and unstructured data [12].

Unstructured data, as texts, audio files, images or videos, can be analyzed, processed and structured to obtain useful information for the next steps of the process, such as predictive analytics [17].

Berruti et al. [18] state that Intelligent Process Automation encompasses five core technologies:

- **RPA**: RPA software tool that mimics the behaviour of a human worker to automate routine tasks.
- **Smart Workflow**: A process-management software tool to initiate and track end-to-end processes.
- **Machine Learning/Advance Analytics**: Set of algorithms that identify patterns in data, through supervised and unsupervised learning and make predictions based on those patterns.
- **Natural-Language Generation (NGL)**: Software engines that create seamless interactions between humans and technology, translating observations of data into unstructured text documents or reports.
- **Cognitive agents**: Set of technologies to build a completely virtual FTE or “agent” that is capable of execute tasks, communicate, learn from data sets and even make decisions based on “emotion detection”.

![Figure 3. Example of an Unattended RPA process](image-url)

![Figure 4. Architectural comparison between Attended (left) and Unattended (right) RPA operations](image-url)
Through the use of Cognitive RPA, the decision-making processes are carried out by robots, so that the automation of long and complex tasks is possible [19]. Additionally, Laurent et al. [20] include the following Artificial Intelligence technologies as components of Cognitive RPA:

- **Natural Language Processing**: Ability of a computer to interpret human language and take appropriate action.

- **Machine Vision**: Ability of computers to identify objects, scenes and activities in images, using sequences of imaging-processing operations and other techniques to analyze images.

5. **RPA CAPABILITIES**

RPA has a wide range of applications in industry, including finance, healthcare, human resources, telecom, and retail, among others [21]. General applications where RPA can be implemented includes:

- Report creation
- Email attachment opening
- Application access
- File and folder movement
- Enterprise tools integration
- Data augmentations via gathering from web
- Data processing

In general, RPA can be implemented to perform tasks that require exchange of information between multiple, unconnected applications [22].

6. **RPA SOFTWARE PROVIDERS**

AI Multiple [23] presents an updated to 2021 list of 82 RPA products, where it is possible to find the RPA market offer for different scales of applications, from RPA 1.0 digital desktop assistants, to the leading market providers which offer the most advanced Cognitive RPA tools.

On the other hand, the Forrester Wave report for the first quarter of 2021 [24] identifies the market leading providers of RPA technology. This report examines the RPA market and highlights what is important to look for in RPA providers [25], taking into account three high-level categories: Current offering, that include task and process discovery and portfolio analysis; strategy, where product vision, delivery and support models and financial performance are evaluated; and market presence, where vendor’s number and dollar value of RPA customers are reflected [26].

Below it is shown a summary of the main the five market leaders in RPA product offering:
UiPath: Named leader for Robotic Process Automation in the 2020 Gartner Magic Quadrant and 2021 market leader according to the Forrester Wave report, UiPath offers a wide variety of RPA products that adapt to the technological needs of its customers [27]. Among its market offer it is possible to find solutions for Desktop Automation, Screen Scrapping, Central Systems Automation and Web Automation, among others.

Furthermore, UiPath offers Cognitive RPA solutions that integrate artificial intelligence to develop bots capable of Document Understanding, Computer Vision and AI Chatbots [28].

Automation Anywhere: Founded in 2003, Automation Anywhere offers RPA solutions that combine Artificial Intelligence and Analytics for automation and management of front and back office tasks, human resources, customer services, finance and accounting, and sales and marketing [29]. Automation Anywhere offers technology independence, with different levels of implementation, including desktop, mobile (iPhone and Android), Cloud, SaaS and Web applications [30].

Microsoft: Power Automate is Microsoft’s RPA End-to-end automation solution. With this product, it is possible to create API-based Digital Process Automation (DPA) and UI-based attended and unattended RPA bots, with the possibility of adding Artificial Intelligence models that allow unstructured data processing, form processing, object detection, prediction and text classification [31].

NICE: NICE’s Process Automation Platform offers AI-based attended and unattended RPA bot designers with focus on real-time text/speech analytics for content ingestion, classification and data processing. Moreover, NICE Automation Finder collects and analyses employee desktop data to identify, suggest and help generate automations [26] [32].

Kryon: Kryon Full-Cycle Automation Suite is a single unified platform that combines attended, unattended and hybrid automation, business process discovery, RPA and analytics in an all-in-one solution [33]. It leverages AI for mining processes to identify the best automation fits and it can even be used for training purposes, suggesting the best path for a user to complete a process [26]. Besides, Kryon’s Cloud RPA-as-a-Service solution allows to implement scalable and flexible RPA systems over Amazon Web Services (AWS) [34].

In addition to the vendors listed above, the Forrest Wave report highlights Blue Prism, Cyclone Robotics, Datamatics, EdgeVerve, Hyland, Kofax, Pegasystems, SAP, and WorkFusion as leaders in the RPA market, stating that their security, access control, and authentication functionalities are appropriate for highly regulated industries [26].

7. RPA METHODOLOGY

This section aims to review good practices when designing and implementing RPA to optimize business processes. Also, mention the common mistakes and general aspects to take into account when carrying out projects with RPA systems.

Dutta [35] states that not all processes are fit for RPA automation. Before considering to automate a process using RPA, it is recommended that the process fulfills the following characteristics:

- Consists on repetitive manual tasks.
- Is rule-based activities
- Medium to high FTE involved
- Has limited human judgement involved in the various activities.
- Has high to medium volumes of transaction.
- Is technically feasible to integrate with supporting systems.
- Has fewer dependencies of unstructured data, such as free text, emails, scanned or handwritten documents.

Champawat [36] exposes six stages to implement a RPA project, where it is expected that structured data has been handled by one or more human employees:

1. Identification: In this stage, the business process to be automated is identified.
2. Discovery and Analysis: The requirements and complexity of the process to be automated are identified and analysed. Then the degree of automation is decided. Also, the benefits/outcomes of the automation are highlighted in this step.
3. Design: A Process Definition Document (PDD), which describes information of each step of the process, is created. Then, to understand the flow of the process, it is modeled on an Object Model Diagram or in a flowchart.
4. Development: Automation script and codes are created with the help of selected RPA tools and technologies.
5. Testing: The resulting bot is tested in a pre-production environment to ensure that is performing as expected.
6. Implementation: Once all the components are tested, unit testing should be conducted. If there are any issues upon diagnosis, then the bot goes back to the development and testing stages.

Moreover, Burger [37] presents a five steps method to implement RPA on work processes:

1. Roadmap Definition: Define clearly which processes create multiple redundant work stages. Then, it needs to be decided the process automation level, deciding how much human interaction is necessary.
2. System Evaluation: Once the automation target has been defined, evaluation of customer-fit RPA software takes place to choose which functionalities and capabilities fit the project requirements.
3. Prototyping: In this step, automation prototypes are design based on the goals and definitions obtained in the two previous steps. This phase demands high level robot engineering skills, tool know-how and deep business understanding.
4. Testing and Transferring: The first automation prototypes are integrated into small work processes.
environments, where they are tested and trained to adapt and then transferred to regular work environments.

5. Multiplying and Evolving: Adapting elements from existing RPA bots to other processes as part of an agile project methodology.

Contrasting the two mentioned methods, it can be noted that identification and discovery and analysis phases from Champawat method can be executed as a whole. Burger’s roadmap definition is clearly a design stage, where the goal is to obtain the Process Definition Document. Then, it is necessary to select the appropriate RPA tool that fits into the target automation process and into the budget of the project. After the target process has been defined and documented, and the RPA tool has been chosen, bot development takes place. Then, the robot prototype needs to be tested and the project enters in a testing-design-development loop that sets the bot to the required state to be implemented.

Finally, it is important to note the Burger’s multiplying and evolving step, where existing bots can be adapted to new target processes.

8. CONCLUSIONS

It is possible to define robotic Process Automation as the constantly evolving technology that encompasses the set of automation software solutions, scalable to different needs and architectures, with the ability to emulate the actions performed by a human worker when interacting with user interfaces, with humans and with other machines during business processes.

This technology can be implemented at different architecture levels, from the simplicity of an isolated desktop computer for the deployment of digital assistants (Assisted RPA), virtualization of autonomous workers capable of controlling processes at the server level (Unattended RPA), up to its implementation in complex and scalable architectures hosted in the cloud (Autonomous RPA), with the possibility of adding artificial intelligence models to perform structured and unstructured data processing (Cognitive RPA).

The evolution of RPA technology can be divided into four phases: Attended RPA, Unattended RPA, Autonomous RPA and Cognitive RPA, differentiated from each other according to their automation capacity, flexibility and scalability.

In addition, it is important to note that although these four stages of RPA differ, they are not mutually exclusive. On the contrary, it is possible to carry out projects where several of these RPA types can be implemented at the same time, depending on the level of automation required at each stage and where a virtualized full-time equivalent (FTE) resource is needed.

Robotic Process Automation is changing the way human resources and business processes are managed and carried out in companies. Task force is no more just the human resources, who are interacting more and more with virtualized peers. Bots are being created more often in order to perform repetitive tasks that are automated through the emulation of human activities in an agile way, in order to generate added value to the company’s processes. As human workers we should adapt ourselves to interact with Robotic Process Automation technology and know how to take advantage of these new resources to focus our human capacities and our inherent abilities in a more creative and spontaneous way, exploiting the value of our mind and human potential.

9. REFERENCES.


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