

Applying Robotic Process Automation in the Banking Industry

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ABSTRACT

In recent years, Robotic Process Automation (RPA) has attracted much attention. With predetermined programs, it can execute tasks that are rule-based, high-information, and repetitive. Nowadays, RPA is used in many areas such as finance, manufacturing, accounting, retail, and supply chains to save time and improve efficiency. However, RPA is seldom used in banking. This thesis conducts a comprehensive analysis of RPA technology, proposing practical suggestions for applying RPA in banking scenarios. The study introduces the concepts, characteristics, and industry status of RPA and presents a case study of a bank integrating RPA; this case study quantifies the cost reduction and efficiency promotion for a particular bank. In addition to the potential benefits, the study also highlights risks and challenges of adopting the RPA technology and proposes efficient methods to mitigate them. Based on the analysis and extensive literature review, this study develops a 5-Step RPA Application Model and introduces three sourcing modes for RPA adoption in the banking industry. Finally, some directions for future research are presented.

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1. Introduction

The automation of robotic processes is a growing trend in recent years, and it is also one of the fastest developing technological evolutions at a company level. Nowadays, “workers spend substantial time dealing with Enterprise Resourcing Planning (ERP), Customer Relationship Management (CRM), spreadsheets and legacy systems in manual repetitive tasks like typing, copying, pasting, extracting, merging and moving massive amounts of data from one system to another.” [1] Robotic Process Automation (RPA) could handle those highly structured, routine, and manual tasks so that workers could have more time for more creative and innovative tasks [1]. RPA can be useful in different business processes, especially in the banking industry.

The main contribution of this study is providing a comprehensive analysis of RPA technology, proposing practical solutions for the adoption of RPA in the banking industry.

1.1 Definition of RPA

RPA is a kind of software robot that performs daily, repetitive, and rule-based tasks similar to human employees, making the existing work faster, more accurate, and more efficient. RPA is the technological imitation of workers with the goal of automating tasks [1]. Although traditional forms of process automation (like screen recording, scraping, and macros) rely on the computer’s user interface, RPA’s core function is via element identification and not by screen coordinates [2]. Unlike traditional methods, RPA is not part of the information infrastructure but rather sits on top of it, implying a low level of intrusiveness, possibly reducing costs [3].

1.2 History of RPA

With the rapid development of automation technology, many industries have increased investment in software automation to improve work efficiency. In the 1990s, IBM, Oracle, and other enterprises used automation technology to promote the automation process in management.

The development of RPA can be traced back to the early screen scraping tools, industrial process software, and even the "Macro" function of Microsoft office. A screen grabbing tool is a data conversion system that automatically grabs the data on the screen and then inputs the data into the database. Screen scraping is now widely used, including in banking, tourism, aviation, and other industries. Process automation software also has many applications, especially when dealing with business processes that need to be approved, modified, or filled in manually.

At the beginning of the 21st century, there is a global upsurge in production costs reduction methodologies, such as the Lean Six Sigma management model, process optimization, business software improvement, and employee outsourcing. In this context, many enterprises use RPA as a means to save costs. At present, they have applied RPA to many repetitive business tasks to improve work efficiency and customer service quality. According to Webinar with Everest Group for Evolution of Robotic Process Automation, the development of RPA technology can be divided into three stages:

- 1) It is based on a principled and structured system to process data in large quantities. For example, it extracts the rule data from email, inputs it into the spreadsheet, stores the data in the internal database, and sends emails to customers and employees.
- 2) It is based on unstructured data and information, deals with more complex work. For example, it uses optical character recognition (OCR) tools to input irregular data into different systems or makes full use of chat robots and voice recognition technology to conduct real-time customer service.
- 3) It is combined with artificial intelligence to deal with cognitive and judgmental tasks. In this stage, RPA is based on professional algorithms, recommends the optimal results, and makes an assistant decision. For example, a robot can recommend the best products

to customers, use machine learning for a loan review, and use professional algorithms for insurance approval. In the future, artificial intelligence will integrate with RPA to drive cognitive automation.

1.3 Features of RPA

Some characteristics that distinguish RPA from other automation technologies are:

- RPA deploys on the existing systems and accesses these platforms through the presentation layer, so no underlying systems programming logic needs to be established [4].
- RPA is a computer-coded software, and it is set to imitate human interaction with applications. It is easy to use by just dragging, dropping, and linking icons.
- RPA does not create a new application and store the transactional data, so there is no need for a database like Business Process Management systems [4].

1.4 Benefits of RPA

RPA will bring huge business opportunities because it will improve employees' productivity and the whole workflow efficiency. Automation is conducive to managing repetitive tasks and standardizing workflow. The main benefits resulting from the implementation of RPA are:

- Save cost: “RPA implementation facilitates cost reduction of 25% to 75% by improving the performance indicators of the applied functions while maintaining production quality” [5]. According to Jones Lang Lasalle, a real estate consultant, it is expected that the consequence of automation of banking processes will reduce the number of branches up to 20% within five years and reduce the size of an average bank branch from 5,000 to 3,000 square feet, which will save as much as USD 8.3 billion annually [6].
- Improve productivity: with the application of RPA, the saved human resources can be used for higher value-added work. RPA will promote the new team division mode of "machine +

human" and make the whole system more efficient. For example, robots can manage information, generate reports, be responsible for data operation and maintenance, and manage accounts; people can handle special businesses, analyze reports, and regularly check business operations. RPA has no working time limitation and can handle global affairs 24 hours a day.

- Reduce work errors: as long as the logic setting is correct, the correct results can be obtained, the error rate would be low, and the data is safe and reliable. If RPA is applied to repetitive tasks, the errors caused by manual operation can be reduced.
- Keep information confidential: unlike other cost reduction methods (such as business outsourcing), RPA can keep all confidential information within the scope of internal staff management.
- Integrate different systems: different types of work and multiple system architectures can be integrated into the same RPA system. At the same time, the RPA system has flexible deployment and robust scalability.
- Reduce business response time: RPA can quickly reply to customers' questions in a standardized manner, improve customer experience, and provide high standard service for a large number of customers at the same time.

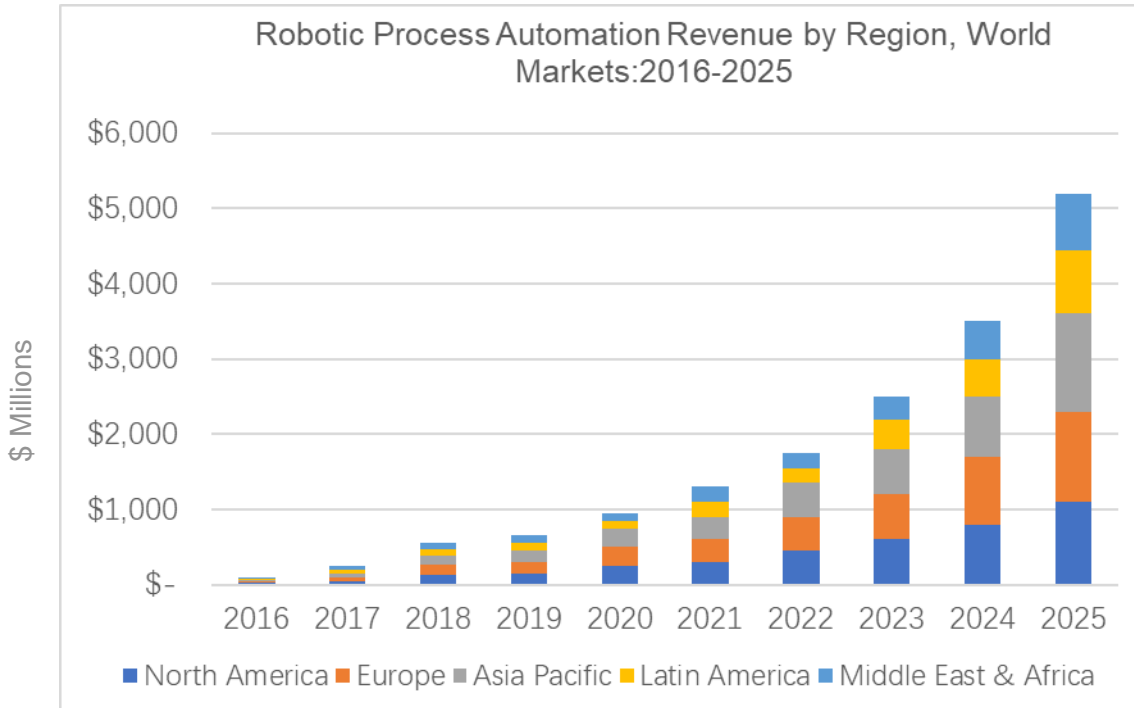
In summary, RPA can assure operational and economic benefits. Banking business process automation can protect customer interests and ensure business succeed. This thesis will introduce industry status and banking business processes suitable for RPA adoption in the next section.

2. Business RPA Adoption

2.1 Market Size for RPA

Driven by companies seeking to improve their customer experience and simplify their business operations, RPA has developed rapidly in recent years. According to the latest Gartner, Inc. forecast, PRA software revenue is projected to reach \$1.89 billion in 2021, increasing by 19.5% from 2020. By 2024, Gartner still predicts a double-digit rates growth in RPA markets from the COVID-19 pandemic [7]. Table 1 shows the PRA market size by region.

Table 1. Worldwide RPA Software Revenue (Millions of U.S. Dollars)



Source: Tractica

2.2 RPA Industry top-performing key players

The world's leading professional RPA companies were established from 2001 to 2005. Some RPA vendors were developed by AI manufacturers or large Internet companies. Nowadays, RPA companies have entered a high-speed development period, and some of the world's top RPA enterprises have operating revenue of more than \$100 million and valuations reaching \$7 billion. Over the next three years, the RPA market will continue to mature. According to Gartner, the ten largest RPA software vendors account for over 70% of the market share in the RPA market [8]. Leaders in the 2020 Gartner Magic Quadrant for RPA are UiPath, Automation Anywhere, and Blue Prism.

2.2.1 UiPath

UiPath, founded in Romania in 2005, is the leader in the RPA market. It has branches in 19 countries and employs more than 3100 people. On Dec. 17, 2020, UiPath filed a confidential draft registration statement with the United States Security and Exchange Commission for an initial public offering with a valuation of \$20 billion-plus [9]. On Feb. 1, 2021, UiPath announced that it had raised \$750 million in Series F funding at a post-money valuation of \$35 billion [10]. UiPath has the following technical features: automatic desktop, web application, flexible virtual terminal, cloud environment hosting mechanism, strong customization, and integration ability. At present, the main products include designer UiPath studio (supporting code programming and graphic programming) and running platform UiPath robot.

UiPath's main application scenarios of RPA focus on finance, supply chain, human resources, customer service, and so on. The main business model is to sell software authorization, partners/agents according to customers' actual situation, delivery implementation. UiPath also

has a strong training community. It has specific universities' courses, publishes relevant books, and is selected as the top of Deloitte's 2019 North American high tech 500.

2.2.2 Automation Anywhere

Automation Anywhere (AA) was founded in 2003. In 2018, it obtained a total investment of US \$550 million from Softbank vision fund, with a revenue of US \$130 million and a post-investment valuation of US \$2.6 billion. In 2019, AA had more than 2400 employees all over the world. It has offices in more than 40 countries and has entered Hong Kong, Taiwan, Beijing, Shanghai, Shenzhen, and other big cities. In 2020, AA built Automation Anywhere Robotic Interface as a digital assistant to automate its internal tasks [11]. AA launched a web-based cloud-native RPA platform. The delivery, operation, and maintenance of products are online. Enterprises can carry out local / cloud hybrid deployment according to their needs. Within the enterprise, employees can start RPA robots through any browser, operating system, or device to realize the "rpa-as-a-service" phase.

By November 2019, AA served more than 3500 business entities with customers in more than 90 countries. It has many head customers that are leaders in financial services and banking, manufacturing, health care, retail, and human resource.

2.2.3 Blue Prism

Blue Prism (BP), started in 2001, went public on the London Stock Exchange in 2016, announcing that it raised £100 million (approximately \$130 million) by issuing new stock [12]. As of 2020, BP served 2,031 enterprises around the world. Jason Kingdon, the chairman and CEO of BP says "We generated 46% growth in revenue, secured £180m in customer commitments, retained 98% of customers by revenue and reduced adjusted EBITDA loss by 47%" [13].

Blue Prism is positioned as an "enterprise-level" product, providing a "centralized" digital labor management and control platform for large enterprises. Enterprise managers use it to allocate labor and improve the core efficiency of critical production processes.

2.3 RPA Adoption in Major Industries

The adoption of RPA covers multiple industries, from finance to utilities. Presently, it is mainly concentrated in the middle and back-office departments of finance, manufacturing, retail, supply chain, human resources, and customer service. The application criterion is segmented into administration and reporting, customer support, data migration and capture extraction, analysis, and others [14]. The study summarized the process in the major industry that is currently reaping the benefits of RPA adoption. Table 2 shows the RPA adoptions in different industries by segment.

Table 2. RPA application in different industry segments

Banking	Insurance	Telecom	Retail	Manufacturing
Know Your Customer	Claims processing	Credit checks	Product categorization	Bill of Material (BOM) processing
Loan processing	Appeals processing	SIM swapping	Automated returns	Inventory Control
Trade execution	Responding to partner queries	Customer dispute resolution	Trade promotions	Proof of Delivery
Same day funds transfers:	Form Registration	Porting customer numbers	Supply chain management	Data Migration
Account Closure	Premium renewals	Report generation	Online sales	ERP Automation
Validating and processing online loan applications	Regulatory Compliance	Simple query forwarding	Inventory monitoring	Administration and reporting
Audits	Risk Mitigation			

2.4 RPA Adoption in Banking

According to Grand View Research, “the banking and financial services industries were market leaders in RPA adoption in 2019, accounting for a 29% share of the global revenue” [15].

This is because many banking business processes involve repetitive, rules-based, and labor-intensive tasks that can be easily be automated.

The most suitable business process must have the following characteristics:

- It can obtain high productivity with low-cost input, save time and reduce cost.
- The business process chosen to apply RPA is stable and will not change frequently, so the RPA related procedures do not need to be updated frequently.
- The business process does not involve much outdated tech. RPA software might not be compatible with legacy infrastructure [17]. Moreover, the on-premise infrastructure should be updated in real time to help with implementing an RPA system [18]. This thesis summarizes three bank business areas where RPA can be implemented based on the business process characteristics, which will be described in the following sections.

2.4.1 The basic repetitive manual work

The basic repetitive manual work includes simple data entry, document filing, information identification, and data transfer. For example, employees are required to manually transcribe all customer handwriting information into the bank system. That handwritten information can be automatically verified, extracted, edited, and converted to electronic form by RPA and intelligent Optical character recognition (OCR) solutions [18].

- **Loan processing:** customers need to submit paper financial statements, credit checks, employment verification, and tax payment certificates to the bank. RPA can validate and cross-check that information, and then decide whether to approve the loan or not based on specific rules.

- **Credit card approval:** the bank uses RPA to input all kinds of customer application information and check the credit, collaterals, and risks. After the condition assessment, RPA can straightforwardly process the card personalization, delivery, and activation.
- **Customer service response:** RPA can collect customer complaints made by email, telephone and on the website and then automatically provide solutions in real-time and reduce turnaround time to seconds.

2.4.2 Cross-system check process

The bank extracts data from the external system and then cross-checks the authenticity and accuracy of the data provided by customers. Cross-system checks include the most basic customer identification checks and suspicious banking transactions catching. This business process aims at anti-money laundering and preventing corruption. Banks need to identify customers, prove the legal source of funds, and strengthen monitoring of holders' account. Also, the bank can connect with the national tax system, provide the tax bureau with the account holders' transaction information, and collect tax payment information from the system to review the accuracy of tax declarations and deductions.

2.4.3 Frequently used and stable operation management system

Considering the development and the following update cost of the RPA platform, banks should first develop it with a stable business process. If the application technology or process often changes with the market, the RPA software needs to be updated frequently. The most frequently used and stable bank' operation management systems include Customer Relationship Management (CRM), Enterprise Resource Planning (ERP) system, internal audit system, and document management system. These kinds of operating systems are less affected by market changes and should be prioritized when applying RPA.

3. Case Study of RPA in Banking

3.1 Banking RPA use case examples

Nowadays, banks begin to use RPA to deal with many simple tasks, and the implementation effect is perfect. With RPA, banks in different countries can relieve their employee pressure, and then their employees can focus on more creative jobs that need people to make decisions. This study introduces several banks in the United States, Netherlands, South Korea, and China that are adopting the technology to discuss the way RPA is being implemented in the banking industry.

3.1.1 United States: Bank of New York Mellon

Bank of New York Mellon in the United States applied RPA as early as 2016 to improve operational efficiency and reduce costs. In 2016, the bank's report mentioned that the application of RPA had achieved extraordinary results: the account closing verification of a typical business across multiple systems reached 100% accuracy. It took only a quarter second to process a transaction using RPA, but it took five to ten minutes manually. In May 2017, the bank announced that in the past 15 months, it had deployed more than 220 robot programs developed by Blue Prism to handle such repetitive tasks.

3.1.2 Netherlands: ING Bank

In October 2016, ING Bank of Netherlands announced a "digital conversion" plan (the RPA system) - to save the workforce by building a digital banking platform. As a result, 5800 employees were laid off first, and another 1200 employees were transferred to other departments. The digital conversion plan saved nearly 900 million euros. In order to achieve the goal of digital conversion, ING Bank plans to invest at least 800 million euros in science and technology

research and development in the next five years to achieve standardization of the bank's data, infrastructure, and workflow and then establish a "Digital Banking platform."

3.1.3 Korea: Shinhan Bank

Shinhan Bank of Korea started to develop RPA in April 2018. In October 2018, Shinhan Bank launched the RPA system, covering 44 subprojects and 21 departments. The RPA system successfully handles more than 6000 tasks per day for Shinhan Bank. The application scope of RPA includes: preparing transaction reports and statements, official registration documents, paying pensions, carrying out asset appraisal, recording taxes and fines, handling foreign exchange remittances, etc.

3.1.4 China: Bank of Nanjing

Bank of Nanjing in China started to implement RPA in April 2018. Through joint construction with Alibaba cloud, more than 30 RPA applications were implemented in October 2019, covering all business lines in the bank, including pre-loan and post-loan processes. Through the operation of RPA, the Bank of Nanjing replaced more than 30 full-time employees, which saved a workload of 10000 employees in a year.

3.2 A detailed use case of RPA in banking operations – RPA in credit card processing

China Minsheng Banking Corporation Limited (“China Minsheng Bank”) was established in 1996. It is China’s first national joint-stock commercial bank initiated and founded mainly by non-state-owned enterprises (NSOEs) [19]. It reported \$1,064 billion in assets at the end of 2020. It had 42 branches in 41 cities across China, with 2,427 banking outlets and over 55 thousand employees at the end of June 2020 [19]. It began adopting RPA in 2020, and it formed a group within its subsidiary Mingsheng Fintech Corporation Limited (“Mingsheng Fintech”) to support the deployment of banking RPA technology.

Traditional credit card processing takes weeks to validate the customer information and manually approve it. The long-time processing period incurs a massive cost to the bank and dissatisfies customers. RPA can help in enhancing both the efficiency and profitability of this process.

3.2.1 Credit card business volume

According to Mingsheng Banks 2020 annual report, it has cumulatively issued 61.67 million credit cards. The number of new credit cards is 4.21 million in 2020. 70% of the new credit cards are applied for through the front desk, and the rest are applied for online or through mobile telephones. So about 2.95 million new credit cards were issued manually in 2020.

3.2.2 Time saved after applying RPA

According to the calculations shown in Table 3, if the bank applies RPA combined with AI technology, the robot can automatically validate and approve the application within 7 minutes. So, it could save 43 minutes per application compared with an employee.

Table 3. Time consumed in each specific process

	Information received from online channels and download	Transcribe Customer Information into the Bank Platform	Credit Scoring & Risk Assessment	Decision making	Total Time Consuming
Manually (Mins)	5	20	20	5	50
AI+RPA (Mins)	5	1.8	0.1	0.1	7

3.2.3 Total cost saved after applying RPA

The average salary of employees at the credit card center of Minsheng Bank is \$2000 per month, the average number of working days is 22 days per month, the working hours are 8 hours per day, so we can calculate the labor cost of an hour is \$12. According to the performance data of Minsheng Bank, the credit card processing could save \$36 million by applying RPA and AI technology. The calculation is as follows:

Cost-saving (per year) = Business volume (new credit cards issued numbers) * Time saving * Employee salary / minute

Cost-savings with applying RPA and AI = 4,215,300 * 43 * \$12/60 mins = \$36,251,580

4. Risks and challenges of applying RPA in Banking

As a data-driven industry, the financial service sector is at the forefront of transformation. RPA adoption is the starting stage of enterprise-wide automation in the banking industry. It is a supplement to the existing labor force, and its main benefits are reducing costs and improving efficiency. However, like any new technology innovation, RPA involves risks and challenges, which we cannot ignore.

4.1 Risks

There are many ways that RPA can lead to risks if not handled effectively. Below are the three most common RPA application risks we regularly encounter, along with suggestions on how to mitigate them: design risk, data-security risk, and bank system inherent risk.

4.1.1 Design risk

Not every process or task is suitable for automation. Repetitive, time-consuming, and rule-based processes are the ideal areas for applying RPA [20]. It is manually performed with a high

level of consistency but requires little judgment. If the bank chooses an unsuitable process, the RPA application will not deliver enough value to the investment.

4.1.2 Data-security risk

Due to the particular characteristics of the banking business, RPA will hold a large number of organizational passwords and credentials to access various information of employees, customers, and suppliers through accessing databases and performing operations. Once manipulated, a large number of confidential business data will be modified or leaked. This data security risk involves unauthorized users accessing confidential data through the RPA platform and connecting data sources without permission. Unauthorized users, such as internal bank employees, RPA suppliers, and malicious hackers, can access the bank's internal databases, network servers, and cloud storage through the RPA platform, stealing confidential data and damaging its specific functions.

4.1.3 Bank system inherent risk

Because the RPA robot controls other software through UI interaction, the development and use of RPA rely heavily on the existing software infrastructure, which is still part of the bank's IT infrastructure. Once the existing platform has problems, RPA must quickly diagnose the problem and find solutions. Also, RPA must activate updates in time if there are updates in the existing software. Otherwise, the RPA robot will stop working and create operational disruptions.

4.1.4 Ways to mitigate risks

It is advisable for banks to establish a business performance team to conduct a detailed analysis to identify and prioritize the automation process. The developer needs a clear version of the existing system where RPA will deploy. The bank also needs to assess the operational issue's

impact and the efficiency gains that RPA will deliver. Each selected process would deliver much more value to the bank if performed more frequently or continuously with a bot's help [20].

To ensure data security, the bank should protect both the data being transmitted and the user who needs to access the data. Based on the HTTPS (SSL) transmission protocol, banks have to encrypt login information and sensitive data; establish unified identity authentication and system authority; include internal audits to record the system operation and access log. The bank also needs to “limit the bots’ access by implementing the principle of least privilege and granting them privileged access only to the specific applications they need to perform their tasks” [21].

The way to mitigate inherent system risk is to create detailed, desk procedure level documentation for each process so that users could be well prepared for disruptions. Another way to mitigate the inherent risk is to establish an abnormal early warning notification mechanism and also to monitor the operation status in real-time.

4.2 Challenges

Despite the obvious and tangible benefits of RPA, the current status of the RPA application in the banking industry is far from exemplary. A Deloitte survey shows that among 400 companies, 30% to 50% of the RPA projects have failed, and 63% have not delivered on time. There are two main reasons.

4.2.1 Resistance to Change

According to ACCA and CAANZ research, “45% of respondents from leading financial organizations listed resistance to adoption as the top challenge stopping them from embracing RPA” [16]. These results demonstrate the fact that the adoption challenge arises from a business challenge, not from a technology one. The Minsheng technology management team also points out that although 83.72% of them said they would like to apply RPA software in their

departments, only 18.6% have used RPA robots to handle their daily work before. This shows that most bank management teams and employees have not used RPA products, and they do not fully understand its technique and working process. Not only are banking executives overwhelmed by the speed of technological change, but also some employees think that the digital workforce will replace human labor. They are not the beneficiaries but the victims of the technological revolution. They also insist that the application of RPA is complex and hard to use. They need to take extra training to learn how to use it, which will bring an additional burden. Thus, the shift in changing managements' mindset is the first step before applying any new technology.

4.2.2 Impractical implementation plan

Applying RPA in bank operations might sound ideal, and in many ways, RPA can help reduce costs and improve working efficiency. However, if the implementation plan is impractical, all the enterprise's expectations and performance goals cannot be achieved. The underlying causes are as follows.

- Process automation's complexity is underestimated, especially when the entity doesn't have an interconnected system, leading to RPA technology's application failure.
- The working team underestimates the time required for RPA deployment, resulting in project delay or abandonment.
- Operation leads pick the wrong process to automate, resulting in the RPA doesn't do the custom job and cannot meet the needs of business upgrading.

4.2.3 Steps to overcome resistance

Implementing modern technology with an established team means teaching new skills to the whole team. Some of the team members are more resistant to changes. So, the RPA application's success rests on clear communication of the project purpose and a practical implementation plan.

Everyone that has to be involved in the application process needs to fully understand what RPA is, why it is important, and how it will benefit the bank. The purpose is to automate repetitive tasks, its human assistant, not labor replacement. It is designed to help employees get rid of those repetitive and boring jobs so that they can focus on more meaningful and high-value work.

The application process should actively involve front-line staff and their department leads so that they will feel valued and have a deep understanding of the technique. The leader should encourage employees to voice their concerns and suggestions in the design stage and continue to seek their input after the implementation on how to improve the process.

The bank should show people how RPA works by automating a certain number of processes. That means starting an RPA project in the bank for just a few tasks, and then broadening the scope to a large scale after learning the first lesson [22]. During this step, the project becomes visible to the organization, and the result can prove the benefits of applying RPA. Furthermore, once employees see a banking robot in action, they will not be threatened that it will take their job. On the contrary, it makes their lives easier.

5. Steps to implement RPA in a Bank

5.1 5-Step RPA Application Model

Based on the above analysis and extensive literature review, this study develops a model for RPA application in the banking industry. The 5-Step RPA Application Model for Banking is divided into the five steps of the implementation process. Figure 1 shows the 5-Step application procedures.

Step 1: Economic viability analysis. The bank's strategic plan should be based on the return on RPA adoption investment. The bank should measure the cost and savings achieved over time with the adoption, and evaluate the existing system, map all of the people involved this process, and assess process automation feasibility. The related costs involve cost of automation, time and change management cost, estimation of return on investment, and scaling of the job fit for automation [23].

Step 2: Identify the pilot processes to be automated. The critical analysis should be done in process scope and fit with current baseline [23]. According to this study's analysis in 2.1, it is better for the bank to choose an introductory test drive to apply RPA to basic repetitive manual work, cross-system checks, and frequently used and stable operation management systems. This step will reduce both the learning curve and risk of failure [22].

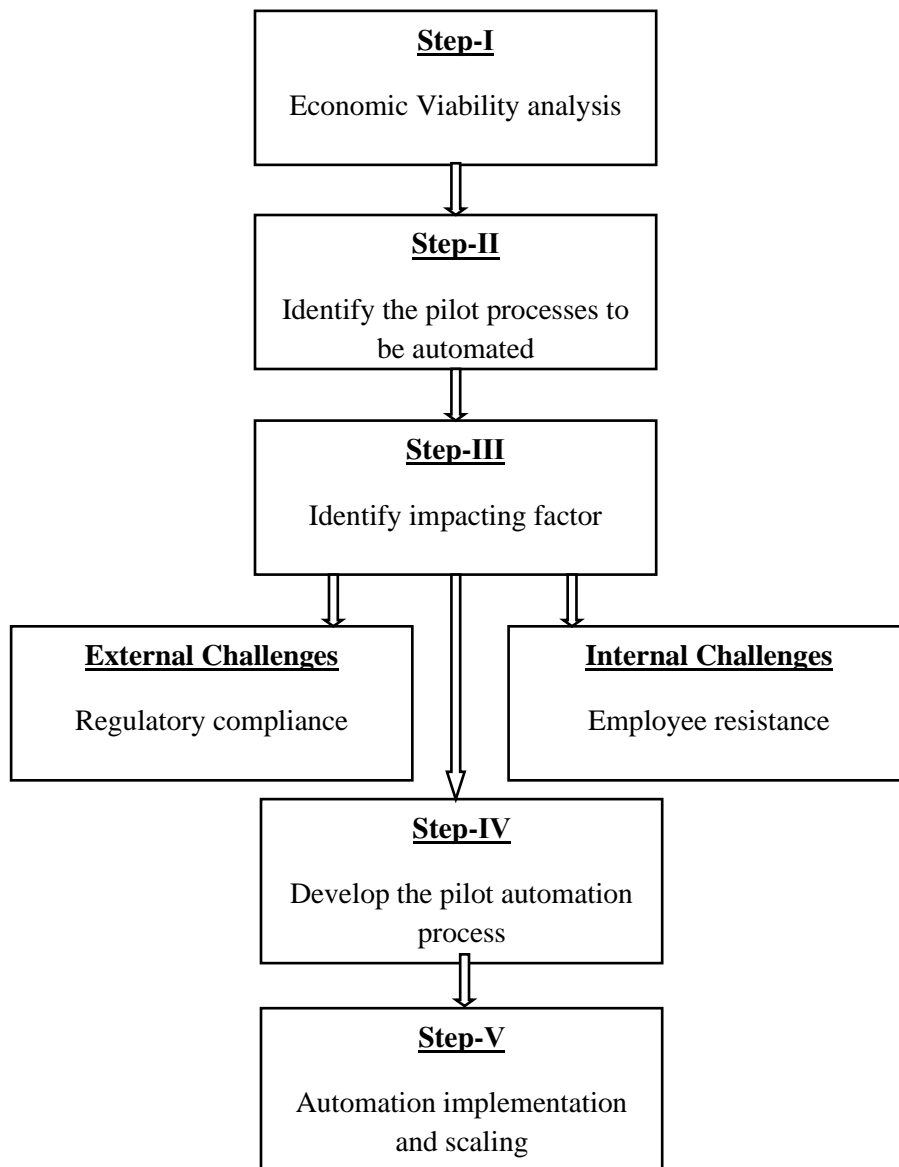
Step 3: Identify internal and external challenges and risks. "Critical analysis of impacting factors is the core element of transformation" [23]. External challenges come from compliance with the statutory obligations. The bank should clearly study government regulations before any transformation. Moreover, internal resistance may come from "employees who distrust change and fear such measures will make their own jobs obsolete" [24]. Clear communication, training,

and engagement will reduce employee resistance and provide valuable insights into the change process.

Step 4: Develop the pilot automation process. Once the bank has the workflow properly mapped, it needs to choose the sourcing method according to the selected automation process. The next section will introduce three sourcing modes for banks to apply RPA.

Step 5: Automation implementation and scaling. Broaden the application to the enterprise-wide scope after learning from the pilot testing.

Figure: 1 5-Step RPA Application Model



5.2 Three modes for banks to source RPA

There are three methods to apply RPA technology in the banking industry: In-house centers of excellence (COE), outsourcing, and hybrid service.

5.2.1 In-house COE

In-house COE is doing RPA on the bank's own, and it is a kind of sourcing method with high requirements. It requires that the bank itself or the bank's technology subsidiary has a strong Research & Development team. Although business between different banks is similar, there are still some differences between them, either in different IT systems or business focuses. By using this method, the bank can design the RPA products that are most suitable for its own business. In addition, in the rapid updating of technology and business today, new needs will continue to emerge. If RPA is designed by the bank itself, the bank can update new functions immediately. Finally, this method is safe and controllable. For banks, there is much sensitive information and confidential data. The data leakage risk is higher if the bank buys the product from a third party. However, internal development also has corresponding disadvantages. Considering that the technology is new for the market, it is hard to find the appropriate specialists. What is more, the investment in their upskilling and reskilling will cost the organization twice as much as retaining tech specialists with mainstream skills [25].

In summary, the in-house COE applies to those banks with strong technical capabilities. It is suitable for those projects with high confidentiality, strong expansibility, and flexible development timeline.

5.2.2 Outsourcing

For banks, direct purchase of the existing RPA software from vendors is the most convenient method. The advantages of outsourcing are low cost, speed, and effectiveness. "RPA

solutions outsourcing allows you to get immediate access to highly qualified resources to launch your RPA project” [25]. Outsourcing from providers with strong internal expertise will ensure a quick start and can achieve maximum efficiency. Also, this method has lower technical requirements for banks themselves because vendors can provide the support tools for the implemented RPA software. Outsourcing also has corresponding disadvantages: technicians may need to enter the bank's operating system, which may lead to data leakage; on the other hand, if the supplier goes bankrupt, it is difficult for the bank to maintain such RPA products, which will bring substantial security risks. So, this approach is suitable for banks with simple rules, sensitivity to costs, and time pressures.

5.2.3 Hybrid service

Hybrid service refers to RPA services that banks have redeveloped based on existing products bought from a professional RPA vendor or cooperating with other vendors to develop RPA technology. Through redevelopment and cooperative development, the bank can create a more adaptable RPA system and train qualified RPA engineers that can provide technical support to system maintenance. For banks with a certain technology capacity, redevelopment or cooperative development is a better choice.

In general, in-house COE of RPA technology can better protect the information security, be better suited to the bank's special business and be more easily updated. However, it also brings great technical difficulty, high development cost, long development time, and increased short-term failure rate. Outsourcing is more efficient and faster, but with confidentiality risks. Hybrid service is the moderate method.

5.3 Match RPA implementation features with business process requirements

In order to show the application scenarios of the three implementation methods, we will analyze the six major business processes of the bank that are suitable for applying RPA: credit card processing, mortgage lending, know your customer (KYC), customer service, regulatory reports, and interbank reconciliation. Banks can choose the RPA implementation methods based on their own business functional needs to maximize efficiency and reduce costs. First of all, we will give a brief introduction to these six business processes.

5.3.1 Credit card processing

The credit card approval process includes customers' background checks, credit checks, cross-system information checks, and decision-making based on that information. This process is very standardized and suitable for outsourcing.

5.3.2 Mortgage lending

Lending is one of the most critical services for banks. RPA allows for automation in this process, which includes credit checks, repayment history, employment verification, and inspection [26]. The automation technology of validating and cross-checking is mature. The cost of self-development and maintenance is too high, so it is suitable for outsourcing.

5.3.3 Know your customer (KYC)

The KYC process is mandatory and extremely data-intensive for banks. This process needs to validate customer data and perform necessary checks and needs 500 to 1000 plus full-time-equivalent employees to perform the process. This process is very standardized and suitable for outsourcing.

5.3.4 Customer service

Banks need to answer multiple queries every day, such as account information, application status, transaction details, and balance information [26]. If a bank addresses customers' relatively standard and straightforward problems, RPA can be directly purchased from vendors; if it also needs decision-making capabilities related to its unique banking business, it is more suitable for hybrid service.

5.3.5 Regulatory reports

The regulatory report is usually in a standard format, and RPA can significantly reduce manual writing pressure and ensure data accuracy. Most of this business is standardized, but it also needs to be adjusted according to the bank's specific requirements, so it is suitable for hybrid service.

5.3.6 Interbank reconciliation

The corresponding RPA technology is required to store the password in the system on one side and input the password analog on the other side. Because it involves much confidential information, it requires high-level security protection and is more suitable for in-house COE.

Table 4 summarizes the sourcing mode for each process in banking.

Table 4 Sourcing Mode for each process in banking

	In-house COE	Outsourcing	Hybrid service
Credit card processing		√	
Mortgage lending		√	
Know your customer		√	
Customer service		√	√
Regulatory report			√
Interbank reconciliation	√		

6. Future Research Trends

RPA is an emerging technology in the rapid development of automating organizational business processes. To make the software more intelligent, combining Artificial Intelligence (AI) with RPA has become the most researched topic. The traditional RPA is more like an actuator, which is used to execute commands. It relies on a strict rule-based method. AI technology can realize the functions of sensors, decision-makers, and feedback. What's more, "the complementary use of AI algorithms and techniques allows to improve the accuracy and execution of RPA processes in the extraction of information in the recognition, classification, forecasting, and optimization of processes" [27].

6.1 AI techniques

6.1.1 Optical character recognition (OCR)

Optical character recognition is the "electronic or mechanical conversion of images of typed, handwritten, or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene-photo (for example, the text on signs and billboards in a landscape photo) or from subtitle text superimposed on an image (for example: from a television broadcast)" [28]. OCR technology is a key technology to realize high-speed text input.

At present, OCR technology has been widely used in various applications, such as "receipt OCR, invoice OCR, check OCR, legal billing document OCR" [29]. A large amount of text data can be quickly, conveniently, and timely input into the computer, realizing "electronic" information processing.

6.1.2 Natural language processing (NLP)

Natural Language Processing is the technology used to achieve effective communication between humans and computers with natural language. NLP is used to read, decipher, understand,

and make sense of human languages in a valuable manner [30]. “When the text has been provided, the computer will utilize algorithms to extract the meaning associated with every sentence and collect the essential data from them” [30].

NLP can be applied to content categorization, topic discovery and modeling, contextual extraction, sentiment analysis, speech-to-text, and text-to-speech conversion, document summarization, machine translation [31].

6.1.3 Automatic speech recognition (ASR)

Automatic speech recognition (ASR) aims to “develops methodologies and technologies that enable the recognition and translation of spoken language into text by computers” [32].

The application of ASR technology includes voice dialing, voice navigation, indoor equipment control, voice document retrieval, simple dictation data entry, etc. Combining speech recognition technology with other natural language processing technologies such as machine translation and speech synthesis technology can build more complex applications, such as speech to speech translation.

Speech recognition is gradually becoming the key technology of the man-machine interface in information technology. The combination of speech recognition and synthesis techniques enables people to get rid of the keyboard and operate through voice commands.

6.2 The AI technology and RPA application scenarios

There are many situations in which RPA can be combined with AI to yield a satisfactory outcome in a business process. The integration will help the bank improve both front-office and back-office processes. RPA software can effectively help with a bank’s data-driven back-office processes, which are high volume and repetitive. At the front end, AI technology can improve customer interactions that are occurring through digital channels. The most effective platform

will successfully integrate RPA with AI technologies, such as OCR, NLP, ASR to offer a fully rounded user experience. Three use cases are as follows.

6.2.1 Use case 1: Credit risk management - RPA + NLP

Besides helping the bank get more things done, RPA and AI technology can play an important role in reducing its operation risks by identifying customers exposed to higher default risk before the default occurs. Failing to continually assess customer's credit and mitigate the risks is costly. Banks need to extract and analyze customer data from different systems based on their digital footprints. It is not feasible for employees to verify all information and predict whether the customer will default or not in a very short time. Identifying whether a customer will default heavily relies on expert judgment. NLP technology can help figure out the meaning behind unstructured text and speech and convert it to structured formats that are unified in the computer system. With NLP, “a range of written media from social media posts to financial news can be captured and used in credit analysis”. Human analysts traditionally performed this type of task [33]. Then “RPA software automatically pulls all the information need to determine if someone is of high or low risk by scouring through variables and values of relationships, co-factors, interactions, dependencies, associations, and more” [34].

6.2.2 Use Case 2: Loan approval - RPA + OCR + NLP

The bank's loan business involves different types of contracts and documents that are typical examples of unstructured content. Banks can benefit from tools that help extract important information in complex contracts or emails. Generally speaking, the contract terms and conditions may be very complicated. It usually takes much time to investigate that information. However, the bank can use the RPA software to extract the content that arrives as an attachment in emails, or if the contract comes in a scanned version, the OCR technology will quickly input

the text into the computer. Then an NLP tool will extract the related information in the contract and create a follow-up checklist. “It can detect and identify their clauses and other relevant parts such as Title, Parties, Date, Term, Assignment, Change of Control, Audit, Governing Law, Force Majeure, Indemnification, Limitation of Liability, etc.”[35] Then the RPA software will insert the related data into the bank's system. AI tools will go over the checklist and decide whether to approve the loan or not based on preset rules.

6.2.3 Use case 3: Intelligent Recommendation System - RPA + ASR

Research indicates that most banks' customers could not satisfy the investment recommendations by calling customer service. RPA and ASR technology could help with this service improvement. The customer service chatbot can determine the customer's needs through a conversation online, and AI tools then complete the corresponding tasks quickly. For example, if a customer wants an investment recommendation, he usually needs to communicate with the bank's salesman at the front desk or by telephone. The salesman then needs to collect the customer's financial information and risk preference and recommend the matched products. If the salesman is not familiar with all financial products, the recommendation may not fulfill the customer's needs. The most effective way is to integrate ASR with RPA in customer service. By analyzing the conversation between customers and the banks' artificial bots, ASR technology can translate customer's speech into text and insert their queries into the bank system. The RPA software can quickly extract customer information such as credit assessments, risk preference, and an annual salary collected before in the bank system. Then AI technology can give the most suitable real-time recommendation through in-depth learning based on the above information. By integrating RPA and AI technology, banks would see dramatic cost cuts, along with improved functionality and increased assistances [35].

7. Conclusion

This study presents an investigation of applying RPA in the banking industry. It was based on the analysis of RPA's concepts, characteristics, benefits, and risks. The main benefits of applying RPA, such as cost reduction, productivity improvement, and error reduction, have been proved. The case study has revealed the cost reduction and efficiency improvement of RPA. Robots implemented in the credit card processing sector could validate and approve the application within 7 minutes, while an employee needs 50 minutes for the same process. This efficiency improvement could save a bank \$36 million a year. However, banks still need to consider the risks, such as cost and possible risks of implementing RPA include development costs, maintenance costs, information confidentiality, and operational security. By analyzing RPA technology characteristics, business owners should prioritize the business processes with lower development costs and higher outputs.

Employees in banks may be skeptical about and resistant to RPA. It is important to communicate the value and launch tactical pilots to make visible those benefits. The bank should focus not only on improving organizational performance but also on investigating the influence on employees so that an optimum balance can be established.

A 5-Step RPA Application Model for Banking has been developed, along with three sourcing modes to implement RPA for the bank's business process. When it comes to deciding on the application of RPA, banks should set realistic goals and expectations and not misuse it for an isolated area. Although RPA technology can drive innovation and maximize competitiveness, it is not suitable for all processes. Banks should constantly monitor their business process to identify the processes suitable for applying RPA.

The combination of RPA and AI technology brings a significant change in the business process, affecting the workflow of digital processes throughout each industry. Technologies like OCR, NLP, and ASR are being integrated with RPA in the business process where unstructured information is analyzed. Future studies are required on cognitive automation tools.

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