Eemi Saarela

ROBOTIC PROCESS AUTOMATION

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF INFORMATION TECHNOLOGY
2024

ABSTRACT

Saarela, Eemi
Robotic Process Automation
Jyväskylä: University of Jyväskylä, 2024, 23 pp.
Information Systems Science, Bachelor's thesis
Supervisor: Kyppö, Jorma

Robotic Process Automation has achieved quite large popularity and interest over the years but has stabilized itself into a regular tool along with other IT based solutions. Definitions of Robotic Process Automation, its uses, and adoption were seen as necessary research topics, so that overall development of the concept can be defined. The purpose of this research paper is to bring together said concept but not to perform more in-depth research of its usage.

Results of this research paper showed that the definition and meaning of Robotic Process Automation hasn't really changed over the years, but its popularity has drastically changed, as Robotic Process Automation has subsided to almost same level as any other regular IT based solution.

Keywords: Robotic Process Automation, RPA usage, RPA adoption

TIIVISTELMÄ

Saarela, Eemi
Ohjelmistorobotiikka
Jyväskylä: Jyväskylän yliopisto, 2024, 23 s.
Tietojärjestelmätiede, kandidaatintutkielma
Ohjaaja(t): Kyppö, Jorma

Ohjelmistorobotiikka on kokenut vuosien saatossa kovinkin suurta suosiota, mutta on myöhemmin vakiintunut normaaliksi työkaluksi muiden IT-ratkaisujen rinnalle. Tämän termistön määritykset ja ohjelmistorobotiikan käytön sekä suosion tutkiminen osoittautuivat tarpeellisiksi toimenpiteiksi, jotta ohjelmistorobotiikan kehityksestä pystyisi muodostamaan paremman kokonaiskuvan. Tämän tutkimuksen tarkoitus onkin tuoda konseptia yhteen, mutta ei suorittaa uutta tutkimusta käytön kehityksestä.

Tutkimustulokset totesivat, että ohjelmistorobotiikan käsitys ja määritys ei ole varsinaisesti muuttunut vuosien varrella, mutta sen suosio on vaihdellut merkittävästi ja on sittemmin laantunut lähes samalle tasolle kuin muilla normaaleilla IT-ratkaisuilla.

Asiasanat: ohjelmistorobotiikka, ohjelmistorobotiikan käyttö, ohjelmistorobotiikan käyttöönotto

FIGURES

TABLES

TABLE OF CONTENTS

1 Introduction

Robotic process automation has been around for some time now, for example the IEEE standard regarding the term was published just in 2017 (IEEE 2017). However robotic process automation is being adopted as businesses are seeing its benefits, for example to reduce business' operational costs (Fung 2014). This trend of adopting Robotic Process Automation as alternative to obtain business and operational results is still going strong and Robotic Process Automation is here to stay as a valid alternative for regular heavyweight IT automation (Penttinen, Kasslin & Asatiani, 2018). Which leads to a need to conduct further research on the topic to attain a better understanding of its advantages and disadvantages.

1.1 Research problem and research questions

The purpose of this research paper is to analyze academic literature and other publications on the field of information systems studies related to Robotic Process Automation to have a better understanding of Robotic Process Automation as a general concept and then investigate its usage and adoption in real-world situations. Following research questions will be answered in this paper:

- How has the definition of robotic process automation evolved?
- How has usage and adoption of robotic process automation changed?

1.2 Research method

This research was made in the form of literature review. The literature used in this research was gathered by using Google Scholar, IEEE Xplore digital library, JYX Digital Repository and Gartner publications. Featured articles were pub-

lished between the years 2012 and 2024. Said articles were evaluated by the classification of the Finnish Publication Forum where possible. Other sources include Google Analytics for trend data on specific keywords.

The search for the articles was performed by using combinations of the following keywords and phrases: robotic process automation, information technology process automation, process automation.

1.3 Research structure

Research paper is structured between three chapters, in the first chapter we go over the Robotic Process Automation as a broad concept, investigating its definition and properties from both top-level IT automation viewpoint as well as in separate subject with individual advantages and challenges. To have a better understanding for the second chapter we also cover generic criteria for Robotic Process Automation adoption.

In the second chapter we cover the general usage and adoption of Robotic Process Automation utilizing previous research and real-world values of certain key metrics, such as interest of general public via Google Search Trends and Robotic Process Automation's market value via Gartner publications. The last chapter is the conclusion where we wrap research together.

2 About Robotic Process Automation

In this chapter we are going to go through Robotic Process Automation on a high level, from the definition of the concept itself and different dimensions of "robotic process automation", how does it fare compared to other alternatives used in the field and what are the use cases for it. The following subchapters each take a different viewpoint of the term to provide wide range of explanation based on academic literature and specialty whitepapers to paint whole picture of the concept of Robotic Process Automation and its usage.

2.1 Definition of Robotic Process Automation

Robotic process automation is defined as a preconfigured software instance which executes processes, activities, and tasks in one or more unrelated software system by predefined set of rules (IEEE, 2017). While Suri et al. (2017) define it as "the concept of using a software platform of virtual robots to manipulate existing application software in the same way that a human does to a process or transaction". The word *robot* in the Robotic Process Automation comes from exactly that, its methodology to utilize existing graphical user interfaces or other front-ends to conduct its predefined tasks to interact with different IT systems on same level as regular human user would by mimicking humanlike actions (Asatiani & Penttinen, 2016).

Syed et al. (2020) researched variation in defining Robotic Process Automation in different papers with the result that there are primarily two main different views on the nature of Robotic Process Automation and software robots as a whole. Either robots, or software, are rule-based and primarily performing repetitive tasks or they are trained with data and are more flexible and capable of adapting to different circumstances. However, these more complex capabilities usually fall under the categories of artificial intelligence or machine learning (Syed at al. 2020).

On basic level this means that Robotic Process Automation processes and tools can be used to fulfill basic and well-defined tasks in a repeatable fashion. Similarly, how other process automation tools like basic macros and scripts have been able to but just offering easier methodology what is more accessible to general workforce to achieve similar results (Penttinen, Kasslin and Asatiani 2018). Van der Aalst, Bichler and Heinzl (2018) refer to Robotic Process Automation as *"RPA is an umbrella term for tools that operate on the user interface of other computer systems in the way a human would do"*, to point out a larger point of view towards the topic.

2.2 Robotic Process Automation vs traditional IT automation

This type of categorization between newer types of IT automation enabled by Robotic Process Automation and similar less intrusive technologies, and more traditional IT automation, which mostly consists of system level integrations is usually referred to as comparison between lightweight IT and heavyweight IT automation (Bygstad, 2017; Lacity and Willcocks, 2015) where Robotic Process Automation is counted as one of more efficient lightweight IT automation methods.

Lacity and Willcocks (2015) also bring out the easiness of Robotic Process Automation which enables regular employees with no programming background whatsoever to automate certain tasks by just using simple graphical interface. However Robotic Process Automation just as any other lightweight IT automation has the potential risk to grow into bunch of isolated gadgets with poor integration (Bygstad, 2017). But companies are able to balance these risks by methods like creating automation centers of excellence to provide dedicated and internal resources to assist and deploy this type of applications (Willcocks, Hindle and Lacity, 2018).

Primary distinctions between these two categories can be generalized on the level which these automation solutions work at. Lightweight IT automation, such as Robotic Process Automation and all most kinds of scripts and macros work against software's or IT system's main operating interface also referred as presentation layer without needing to have invasive access to its background services or underlying data systems. (Bygstad, 2017; Lacity and Willcocks, 2015; Penttinen et al., 2018)

A more specific comparison between these two distinct categories has been outlined by the work of Penttinen et al. (2018) and can be referred to from table 1. While more exact advantages and challenges of Robotic Process Automation itself will be covered in further detail in the next chapters.

TABLE 1 Comparison of lightweight and heavyweight ITs (Penttinen, Kasslin and Asatiani 2018)

Feature	Lightweight IT	Heavyweight IT
Type of systems	GUI automation	Back-end systems automation
Technology	Emergent, spontaneously adopted	Mature, proven
Culture	Business and process improvement	Software engineering
Focus	Agility, innovation, speed	Security, efficiency, reliability
Application area	Unknown, development of new services	Well-understood and known services
Invasiveness	Non-invasive, presentation layer	Invasive, data-access and business logic layer
Problems	Isolated systems, privacy and security issues	High complexity and costs of systems

2.3 Advantages and benefits of Robotic Process Automation

As discussed previously, the main advantage of Robotic Process Automation tools is their ability to utilize the already existing presentation layer or graphical interface without requiring further changes to already existing IT software. This ability is especially effective when dealing with monolithic IT systems where software or code level changes would be expensive or even impossible, in cases where software's source code is no longer available or other 3rd party integration solutions utilizing either paywalled or non-existent APIs wouldn't work (Asatiani and Penttinen, 2016). For example, this could be the situation where company is utilizing legacy software in its core business process but modifications to that software are no longer possible due either used version already being out of support or even the provider company not existing anymore.

The second advantage of Robotic Process Automation according to Asatiani and Penttinen (2016) is the ability to develop and deploy new solutions in very quick timeframe without large development costs what are usually the case with enterprise-level system integrations. Third advantage by Asatiani's research group (2016) is Robotic Process Automation workflows' easy of usage, as to make and modify these tools and workflows is no longer something what is restricted to only traditional software developers, but even regular employees are able to modify, alter and reuse existing modules within Robotic Process Automation (Slaby, 2012). These already existing modules can then be easily expanded by others without significant software knowledge (Mehti and Chaher, 2022).

Robotic Process Automation boasts greatly improved accuracy compared to regular work force as humans are human and will always be susceptible for

small mistakes. While properly made Robotic Process Automation workflow is able to keep up with high accuracy goals with reliable consistency (Fung, 2014; Asatiani and Penttinen, 2016; Suri, Elia and Hillegersberg, 2017; Mehta and Charer, 2022).

This level of accuracy is even reached with RPA robots working tirelessly 24/7 (Slaby, 2012). Which leads to the main benefit for companies and organizations adopting Robotic Process Automation is its direct ability to reduce the required FTEs spend for organization's core processes. According to Santos and his research group (2020) companies are able to achieve significant FTE savings by updating their processes to work with these RPA robots. While Ribeiro et al. (2021) claim that reports present even a 30% to 50% decrease in operational technologies under specific circumstances.

In organizations what are ready to change their mind and processes the Robotic Process Automation mindset can be embraced. Lacity and Willcocks (2016) bring forward the idea of CoE (Centre of Excellence) with necessary leaders and drivers what enable organizations to stick to their strategy and involve all other required people to achieve success in new implementations of Robotic Process Automation workflows. In his paper Anagnoste (2018) describes example framework for Robotic Process Automation CoE which is required for when organization's RPA robot usage matures from pilot phase to gain higher efficiency. This type of driver is required to be outside of traditional IT as otherwise IT-centric bubble might harm further implementation and development which leads Robotic Process Automation not to reach its full potential (Lacity and Willcocks, 2016; Willcocks et al, 2015).

2.4 Challenges and risks of Robotic Process Automation

However, Robotic Process Automation isn't a miracle solution for everything, which is why companies always need to make the decision when utilizing RPA robots or Robotic Process Automation in general or when to rely on conventional heavyweight IT automation (Penttinen, et al., 2018), or when rely on regular knowledge worker's own output.

In essence, Robotic Process Automation offers quick and fast methodology to attain certain feats when it comes to integrating different IT systems or assist workflows, this however isn't a permanent solution and is described more to be an "ad-hoc glue" what is only temporary solution (Asatiani and Penttinen, 2016; Van der Aalst et al., 2018).

By default, RPA robots and other solutions made with Robotic Process Automation principles are restricted to their own definition, as RPA robots are only capable of processing such data what is programmed or configured on them by following strict rule-based process (Asatiani and Penttinen, 2016; Penttinen et al, 2018). This leads to a situation where the more complex the task is, the more complex it is to automate and in certain situations automating such process might not even be worthwhile endeavor, as the automation task itself

can grow into too complex or there might still be too large of a need for actual knowledge worker to assist the robot in certain tasks (Asatiani and Penttinen, 2016).

Job security is a common topic in related literature as cost savings are the corresponding advantage of Robotic Process Automation adoption. (Lacity and Willcocks, 2018; Penttinen et al, 2018; Suri et al., 2017). This comes from the fact that only realized cost savings are actual savings, however some companies might just accept the raised overall efficiency alone as the perk. While Lacity and Willcocks (2015) try to soothe the fears of knowledge workers that the RPA robots will empower them and not replace them, however they do acknowledge on a later article (2016) that fear of replacement is prevalent within the workforce. This is also supported by Frey and Osborne (2017) who go even further and claim that even 47% of modern work can be automatized within 20 years, which leads to a need for knowledge workers to be even more adaptable for new challenges.

Robotic Process Automation like other lightweight IT automation solutions come with their own security and privacy issues which are harder to respond to unlike their more heavyweight counterparts (Penttinen et al., 2018). These issues with cybersecurity and data privacy are considered to be one of the largest challenges with its implementation, this happens because by its nature RPA robots utilize already existing user interfaces what may include sensitive information and therefore secure development practices are needed (Choi, R'bigui & Cho, 2021a). RPA robots work as humans from the point of view of the IT systems themselves which means that they are able to use already established role-based access controls and management (Mehta and Chaher, 2022). But in more regulated sectors, legislation might affect these access requirements which causes its own overhead on successful RPA implementation (Gotthardt et al, 2020). Regular security audits and general security surveillance over these RPA robots and their actions work to mitigate these risks (Anagnoste, 2018; Hoffman, Samp and Urbach, 2020).

2.5 Criteria to adopt Robotic Process Automation

In their research, Santos, Pereira and Vasconselos (2020) identified thirteen separate criteria requirements based on earlier research on the field to assist organizations to dictate which of their processes are suitable for Robotic Process Automation implementation. In this subchapter we'll cover each criteria in detail and provide derivative examples.

2.5.1 Awareness of current costs

For an organization to be able to make an educated decision for when to implement Robotic Process Automation and replace parts or whole of a current

workflow they first need to be aware of current costs of this workflow, without such knowledge they are unable to calculate actually ROI and worthiness of development task as manual cost might be still lower than the cost and usage of automation (Asatiani and Penttinen, 2016; Fung, 2014; Slaby, 2012).

For example, some manual tasks can be so quick but require complex workflow which isn't as easily replicable, so developments costs to turn it into an RPA robot raise enough to disprove potential ROI value.

2.5.2 Ease of decomposition into unambiguous rules

Process and its tasks are necessary to be able to split into clear and unambiguous parts which are able to follow defined rules (Fung, 2014). If process can be split into multiple clear and unambiguous tasks it can be automated with an RPA robot (Asatiani and Penttinen, 2016). Even if not all tasks in the process are such that they can be automated with the RPA robot, some of them can and rest can be still managed by a knowledge worker who is attending the robot (Choi, R'bigui & Cho, 2021b).

For example, some finance and accounting related tasks might require a human to verify and sign-off certain parts of otherwise easily automatable solution due to country specific legislation or equivalent.

2.5.3 Frequent interaction with multiple systems

If a knowledge worker is required to utilize multiple different systems to complete their tasks, the risk of manual errors increase and such workflows might be a good candidate to automate (Fung, 2014; Penttinen et al., 2016).

For example, if a worker needs to constantly switch between two separate IT systems, like organization's ERP and WMS (Warehouse Management System) to update order details, they might make mistakes in manual input of values.

2.5.4 High availability of digital data

Anagnoste (2017) highlights that the digital data used by any RPA robot needs to be highly available. For example, an RPA robot's development is considerably easier, when necessary API-endpoints and interfaces are available to it without jumping through unnecessary hoops.

2.5.5 High level of process standardization

High level of process standardization is also related to process ability to be easily decomposed into unambiguous rules, as better the process is standardized, fewer exceptions happen to it (Lintukangas, 2017). When multitude of exceptions do not need to be counted for automation of such process becomes easier which on other hand saves on development time (Slaby, 2012).

For example, if an RPA robot is supposed to be handling specific type of form and use its contents against multiple IT systems, it is paramount that the process is standardized without large amount of variables which alter the course of workflow.

2.5.6 High process maturity

High process maturity enables an organization to properly understand the needs and challenges of the current process prior to they are able to make educated decisions to automate them. The more mature the process, the better documentation and mindfulness can be achieved. (Lacity and Willcocks, 2016; Lintukangas, 2017).

For example, if an organization is not properly aware of how certain business processes work, they are most likely not be able to provide proper insight and decision-making before turning them into RPA robots as they might not be aware of all parts of costs of current processes.

2.5.7 High quality of data

Quality of data matters when deciding to implement Robotic Process Automation for specific task, as when an RPA robot follow specific set of pre-defined rules (Fung, 2014) it does not take into consideration if used data itself is not valid (Anagnoste, 2017; Liutukangas, 2017). For example, if an RPA robot is used in finance or accounting tasks but its input includes corrupted data, it might generate massive amounts of errors in few seconds (Denver, 2020).

2.5.8 Limited need to handle exceptions

Related to the high level of process standardization, process also needs to have limited need to handle exceptions (Asatiani and Penttinen, 2016). While exceptions themselves can be added to the bot, their implementation is time-consuming to automate (Slaby, 2012).

For example, an RPA robot which processes certain manually filled documents might require extensive exception handling to process certain types of common mistakes to either handle them by itself or redirect them to human operator.

2.5.9 Low need of cognitive requirements

Traditionally Robotic Process Automation is not suitable for tasks which require high cognitive skills (Lacity and Willcocks, 2016) as RPA robots lack analytical and creative skills (Santos, et al., 2020). However, this might change with developments in the field of artificial intelligence and LLM-research (Van der Aalst, et al., 2020).

For example, a traditional RPA robot is not suitable for generating analytical decisions from a given dataset, nor can it provide creative mindset but only follow given rules.

2.5.10 No need or limited work intervention

Processes what require no or limited intervention from human users are easier to automate as while humans attending to an RPA robot to provide decisions and prevent mistakes is viable, it is always harder to implement (Choi, R'bigui & Cho, 2021b).

For example, an RPA robot which can download material and trigger itself is more efficient to use in the long run compared to an alternative RPA robot which requires a human to fetch the materials and input them for it.

2.5.11 Stable systems

IT systems which an RPA robot interferes with need to be stable, meaning that they do not change very often, as even small changes to graphical user interface might cause the RPA robot to fail to fulfill its task and require more development work (Penttinen, et al., 2018; Slaby, 2012).

For example, if an IT system like an ERP gets minor visual updates in a quick cycle, it might break down the RPA robot using its interface on every update which causes downtime for the RPA robot and increases development time and costs.

2.5.12 Tasks prone to human errors

Tasks prone to human errors are suited for Robotic Process Automation because properly configured and developed RPA robot makes no human errors. (Asatiani and Penttinen, 2016; Fung, 2014). For example, when doing large amounts of manual data entry, the amount of human error increases but an RPA robot is not exposed to such risks.

2.5.13 Volume of transactions

Voluminous transactions are a good candidate for Robotic Process Automation as they have the highest opportunity for cost reduction (Lintukangas, 2017) as RPA robots excel in highly repetitive tasks in terms of speed and quality (Asatiani and Penttinen, 2016). For example, if an entry to an IT system needs to be done thousands of times a day, developing a suitable RPA robot for it potentially has clear ROI.

3 Usage and adoption of Robotic Process Automation

In this chapter, we'll cover both usage and adaptation of Robotic Process Automation, by first looking at examples from different industries how well have they affiliated with Robotic Process Automation in general and then looking at adaptation in general compared to more global and universal metrics without specific onlook at specific industries, such as how Robotic Process Automation's market value has changed or how is the perceived public interest changed over the years.

3.1 Usage of Robotic Process Automation

Robotic Process Automation has grown to be an excellent tool for assisting replacing regular human knowledge workers across multiple industries and sectors (Anagnoste, 2017; Frey & Osborne, 2017; Lacity & Willcocks, 2015). Industries which have plentitude of manual tasks which fill some or all parts of the criteria for Robotic Process Automation adaptation include industries such as finance and accounting (Gotthardt et al., 2020) and digital marketing (Mehta & Chaher, 2022). However, Robotic Process Automation solutions have potential in all situations where they can assist or replace these knowledge workers (Slaby, 2012; Willcocks et al., 2015).

The academic field is full of case studies and smaller reports made on either singular entities or smaller concentrations of organizations, as searching platforms like Google Scholar on April 14, 2024, for "Robotic Process Automation + Case study" returned over 8000 results. Enríquez and his research team (2020) performed systematic mapping study on 54 of these publications found that while interest on studying Robotic Process Automation has increased over the years, these studies are mostly focused on the lifecycle of Robotic Process Automation from deployment all the way to performance but lack insight on analysis of implemented solutions themselves.

3.2 Adoption of Robotic Process Automation

There are no clear research done on actual adaptation numbers of Robotic Process Automation in general public as this type of research is usually left on hands of industrial researchers on enterprise level (Enríquez, et al., 2020). However, we are somewhat able to figure out general trends by relying on tools such as Google Trends. As seen on Figure 1, the market hype reached its peak around 2020 but has maintained regular levels of interest since 2022, this follows predictions of Lacity and Willcocks (2015) that Robotic Process Automation is becoming more commonplace in general and just a tool like any other in terms of different solutions (Penttinen, et al. 2018). In their review of Robotic Process Automation publications, Santos et al. (2020) and other researchers (Wewerka & Reichert, 2023) noticed similar increasing trend from 2018 to 2020 which directly corresponds with public interest obverse via Google searches alone. But the amount of Robotic Process Automation publications has similarly started to slow down in the same way as general interest (Fernandez, et al. 2024).

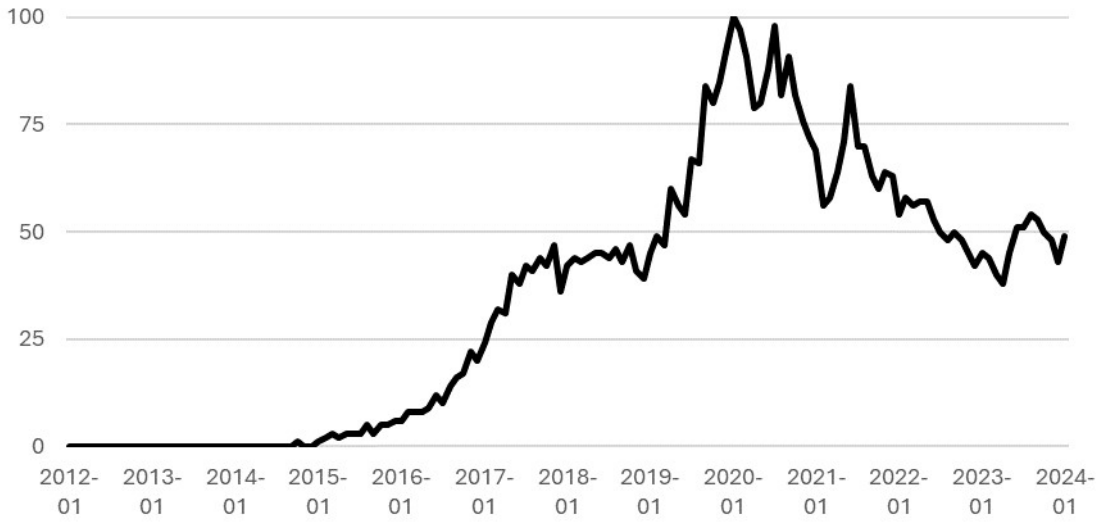

Figure 1 Interest in Robotic Process Automation in terms of Google searches (retrieved from Google Trends)

The slowing rate of general interest as shown on Figure 1 also explains the general slowing down of market value changes of Robotic Process Automation which originally were staying above 60% for years of 2018 and 2019 where Robotic Process Automation market beat regular enterprise IT software market threefold due very high demand around the topic, which it still manages to do

but not at similar levels. But general growth has drastically slowed down, possibly due Robotic Process Automation no longer being the buzzword in enterprises or companies have already achieved some level of adaption of Robotic Process Automation tools (Gartner, 2020, 2021, 2022, 2023).

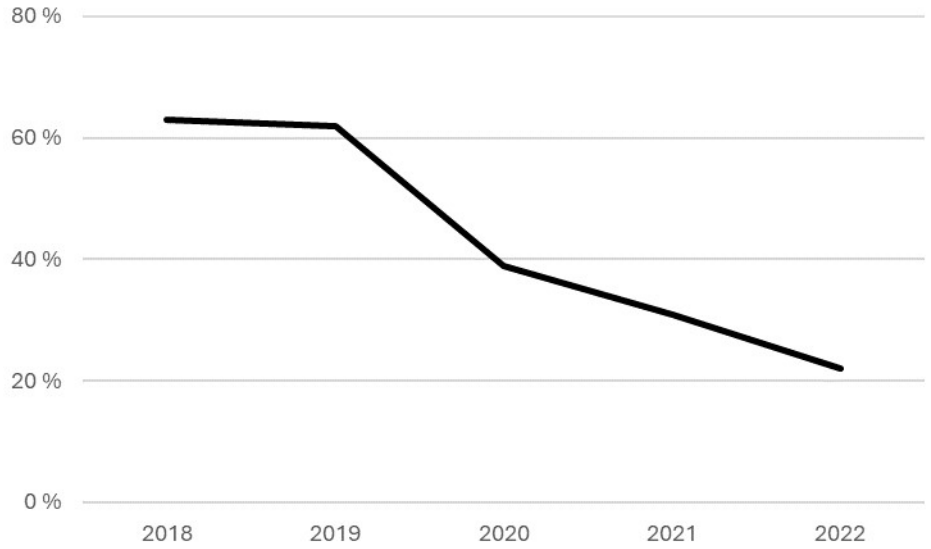

Figure 2 Robotic Process Value market value change per year according to Gartner Magic Quadrants for Robotic Process Automation.

4 Conclusion

The research paper's purpose was to define Robotic Process Automation as a broader concept and then research its current uses and adoption in the real-world examples. Research paper had two separate research questions:

- How has the definition of robotic process automation evolved?
- How has usage and adoption of robotic process automation changed?

Definition of Robotic Process Automation has changed somewhat to more accurate view as shown in research of Santos et al. (2020), but the main points of the definition have stayed somewhat the same even since IEEE's (2017) original definition of the topic in 2017. But in essence, Robotic Process Automation still presents a significant advancement in the way organizations can streamline their business processes to enhance efficiency and reduce costs.

The usage and adoption of Robotic Process Automation has increased steadily, even though it has no longer reached similar levels as during its peak hype from 2018 to 2020. This is most likely explained by its normalization into a common place tool within industries and different organizations, seen just as another tool for specific automation problems and not as magic software which solves everything.

However, the results of this research paper show that there is still a need for more research on actual adoption of Robotic Process Automation in industry agnostic viewpoint, as well as industry themed research with more focus analysis itself as Enríquez (2020) points out in his research group's publication.

REFERENCES

Anagnoste, S. (2017, July). Robotic Automation Process-The next major revolution in terms of back office operations improvement. In Proceedings of the International Conference on Business Excellence (Vol. 11, No. 1, pp. 676-686).

Anagnoste, S. (2018). Setting up a robotic process automation center of excellence. Management Dynamics in the Knowledge Economy, 6(2), 307-332.

Asatiani, A., & Penttinen, E. (2016). Turning robotic process automation into commercial success–Case OpusCapita. Journal of Information Technology Teaching Cases, 6, 67-74.

Canneroth, A., & Hellmuth, A. (2020). Examining the Critical Success Factors for Robotic Process Automation in Small-Medium Enterprises.

Choi, D., R'bigui, H., & Cho, C. (2021a). Robotic process automation implementation challenges. In Proceedings of International Conference on Smart Computing and Cyber Security: Strategic Foresight, Security Challenges and Innovation (SMARTCYBER 2020) (pp. 297-304). Springer Singapore.

Choi, D., R'bigui, H., & Cho, C. (2021b). Candidate digital tasks selection methodology for automation with robotic process automation. Sustainability, 13(16), 8980.

Denver, C. (2020). Auditing the Bots. The Internal Auditor, 77(1), 16-19.

Enríquez, J. G., Jiménez-Ramírez, A., Domínguez-Mayo, F. J., & García-García, J. A. (2020). Robotic process automation: a scientific and industrial systematic mapping study. IEEE Access, 8, 39113-39129.

Fernandez, D., Dastane, O., Omar Zaki, H., & Aman, A. (2024). Robotic process automation: bibliometric reflection and future opportunities. European Journal of Innovation Management, 27(2), 692-712.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation?. Technological forecasting and social change, 114, 254-280.

Fung, H. P. (2014). Criteria, use cases and effects of information technology process automation (ITPA). Advances in Robotics & Automation, 3.

Gartner. (2020). Magic Quadrant for Robotic Process Automation (G00441474) https://www.gartner.com/document/3988021

Gartner. (2021). Magic Quadrant for Robotic Process Automation (G00733929) https://www.gartner.com/document/4004033

Gartner. (2022). Magic Quadrant for Robotic Process Automation (G00756568) https://www.gartner.com/document/4016876

Gartner. (2023). Magic Quadrant for Robotic Process Automation (G00776666) https://www.gartner.com/document/4595599

Gotthardt, M., Koivulaakso, D., Paksoy, O., Saramo, C., Martikainen, M., & Lehner, O. (2020). Current state and challenges in the implementation of smart robotic process automation in accounting and auditing. ACRN Journal of Finance and Risk Perspectives.

Hofmann, P., Samp, C., & Urbach, N. (2020). Robotic process automation. Electronic markets, 30(1), 99-106.

IEEE Corporate Advisory Group. (2017). IEEE guide for terms and concepts in intelligent process automation. IEEE Standards Std, 2755, 1-16.

Lacity, M. C., & Willcocks, L. P. (2016). A new approach to automating services. MIT Sloan Management Review, 58(1), 41-49.

Lacity, M., & Willcocks, L. (2015). What knowledge workers stand to gain from automation. Harvard Business Review, 19(6), 23-46.

Lintukangas, A. (2017). Improving indirect procurement process by utilizing robotic process automation. Master's thesis.

Mehta, R., & Chaher, R. (2022, May). Implementation of robotic process automation (RPA) in digital marketing. In 2022 3rd International Conference for Emerging Technology (INCET) (pp. 1-4). IEEE.

Penttinen, E., Kasslin, H., & Asatiani, A. (2018, June). How to choose between robotic process automation and back-end system automation?. In European Conference on Information Systems 2018.

Ribeiro, J., Lima, R., Eckhardt, T., & Paiva, S. (2021). Robotic process automation and artificial intelligence in industry 4.0–a literature review. Procedia Computer Science, 181, 51-58.

Santos, F., Pereira, R., & Vasconcelos, J. B. (2020). Toward robotic process automation implementation: an end-to-end perspective. Business process management journal, 26(2), 405-420.

Slaby, J. R. (2012). Robotic automation emerges as a threat to traditional low-cost outsourcing.

Suri, V. K., Elia, M., & van Hillegersberg, J. (2017). Software bots-the next frontier for shared services and functional excellence. In Global Sourcing of Digital Services: Micro and Macro Perspectives: 11th Global Sourcing Workshop 2017, La Thuile, Italy, February 22-25, 2017, Revised Selected Papers 11 (pp. 81-94). Springer International Publishing.

Syed, R., Suriadi, S., Adams, M., Bandara, W., Leemans, S. J., Ouyang, C., ... & Reijers, H. A. (2020). Robotic process automation: contemporary themes and challenges. Computers in Industry, 115, 103162.

Van der Aalst, W. M., Becker, J., Bichler, M., Buhl, H. U., Dibbern, J., Frank, U., ... & Zdravkovic, J. (2018). Views on the past, present, and future of business and information systems engineering. Business & information systems engineering, 60, 443-477.

Van der Aalst, W. M., Bichler, M., & Heinzl, A. (2018). Robotic process automation. Business & information systems engineering, 60, 269-272.

Wewerka, J., & Reichert, M. (2023). Robotic process automation-a systematic mapping study and classification framework. Enterprise Information Systems, 17(2), 1986862.

Willcocks, L. P., Lacity, M., & Craig, A. (2015). The IT function and robotic process automation.

Willcocks, L., Hindle, J., & Lacity, M. (2018). Keys to RPA success. Executive Res. Rep., Knowl. Capital Partners, USA, Tech. Rep.