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The Trends and Roles of Robotic Process Automation Technology in Digital Transformation: A Literature Review

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Abstract. Digital transformation is one of many initiatives that could be considered a common strategy to overcome disruption issues in many companies, industries, and organizations. Initiating the digital transformation will maintain companies' performance, efficiency, and compliance. An essential factor of digital transformation is technology. The emergence of various digital technologies brings possibilities to initiate the digital transformation journey. One of those emerging technologies is Robotic Process Automation. This research aimed to conduct a comprehensive literature review by adopting Kitchenham and PRISMA procedures. Forty-two pieces of literature from seven databases were analyzed bibliometrically and qualitatively to determine the trends and roles of Robotic Process Automation in digital transformation and the extent to which it can be utilized. This study has contributed theoretically and practically to the community. Theoretically, the trend of Robotic Process Automation in digital transformation research since its emergence up until now has been identified. It gives a baseline for future researchers to start another study and will reduce the knowledge gap between industry and academic research. Practically, this study provides many insights for the practitioners and enterprises on how Robotic Process Automation can be utilized to enhance their digital workforce. Best practices and success factors have been summarized from some areas of implementation. This technology is considered an important new technology to be utilized in a digital transformation initiative. However, it can be appropriately used under certain circumstances and conditions, as reported in detail in this article.

Keywords: robotic process automation, digital transformation, systematic literature review, bibliometric analysis

1. Introduction

Digital disruption along with its digital economy and digital workers are now becoming common issues faced by many companies and organizations. It brings a massive change in society, industry, and business. To deal with it, an enterprise needs to create a robust strategy to keep the business sustainable (Yucel, 2018). Digital Transformation (DT) is one strategy widely adopted to explore new digital technologies and exploit their benefits (Matt et al., 2015). DT is one of the significant challenges for traditional businesses, affecting all corporate functions, procedures, processes, operations, services, and products (Bouncken et al., 2021; Dehnert, 2020; B. George & Paul, 2019). Digital transformation has been identified as an essential movement for a company to deal with the disruption of its business models. DT deals with the business process performance issues. Digital transformation is defined by (Hess, Matt, et al., 2016) as the changes digital technologies can bring in a company's business model, products, processes, and organizational structure

Generally, DT consists of 4 key dimensions, i.e., the use of technology, changes in value creation, organization structural changes, and financial aspects(Hess, Benlian, et al., 2016; Matt et al., 2015; Verhoef et al., 2021). The use of new technologies is one of the key dimensions of DT. Digital technology is an integrated and mandatory dimension for DT initiatives. Therefore, identifying the suitability of new digital technology for DT is an essential step toward a successful DT initiative. A cutting-edge and emerging technology that possibly can be utilized to process the DT is Robotic Process Automation (RPA) (Sobczak, 2021). Gartner, in their report, stated that the RPA software market continues to be one of the most rapidly growing segments, with its 38.9% growth in 2020 (*Magic Quadrant for Robotic Process Automation*, 2021). There are more than 60 vendors in the RPA software market as of mid-2021(*Magic Quadrant for Robotic Process Automation*, 2021). RPA is expected to automate more than half of existing human-system interactions, resulting in significant performance improvements (Kirchmer & Franz, 2019).

Robotic Process Automation is defined by IEEE as a preconfigured software utilizing business rules and predefined activity choreography to complete the autonomous execution of processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management(IEEE Corporate Advisory Group, 2017). It creates automation of human-computer interaction without impacting an enterprise's or organization's existing IT infrastructure. Therefore it can be implemented quickly compared to the previous digital transformation technologies (Maalla, 2019), (Van Chuong et al., 2019). There are three different models of RPA, i.e., attended, unintended, and hybrid models (Axmann & Harmoko, 2020). The attended model uses RPA as a personal assistant for the individual worker. It works by receiving a command from the worker. The unintended model uses RPA to automate the process from multiple workers without human interventions. Coming in the middle of those models is the hybrid model. The hybrid model executes some processes automatically while, on the other hand, still accommodating the user intervention in some parts that need cognitive decisions (Axmann & Harmoko, 2020).

RPA is a relatively new technology approach that potentially can be utilized in a digital transformation initiative by automating the business processes in an enterprise (Lacity & Willcocks, 2016). In RPA, the tasks are completed to simulate human-machine interaction behaviour (Maalla, 2019). Based on those RPA's characteristics and definitions, RPA should be considered an emerging and cutting-edge technology that can be utilized in a digital transformation journey (Siderska, 2020). It can be used to achieve various goals, including process performance, efficiency, scalability, security, convenience, and compliance (Hofmann et al., 2020), (Wewerka & Reichert, 2020).

To the best of our knowledge, there has never been a comprehensive Systematic Literature Review (SLR) about the recent trend of RPA technology in digital transformation initiatives. The SLRs that have been conducted covered only a review of the RPA technology in general. Another concern is the gap of knowledge between industry and business with the academic research about RPA technology. Many industry have been utilizing this technology, on the other side the are only view research in this area. This research aimed to reduce this gap; hence there will be a match and link between academic research and the business or industry. Therefore, this study presents an SLR aimed at answering this issue with the following five research questions (RQs)

RQ1: How is the research trend and the relations of RPA with DT?

RQ2: What are the roles of RPA technology in DT initiatives?

RQ3: In which business areas are RPA been implemented?

RQ4: What factors determine the success of RPA in DT initiatives?

RQ5: What kind of business processes are suitable for RPA?

2. Material and Methods

Kitchenham procedure (Kitchenham, 2004) was adopted to conduct this systematic literature review, as shown in Figure 1. This procedure mainly consists of 3 phases, i.e., planning, conducting, and reporting the review. In the planning stage, we identified that to the best of our knowledge; there is no comprehensive systematic literature review on RPA technology concerning DT. Hence there is a need to conduct a study in answering this issue. We then developed a review protocol and conducted this study.

We retrieved articles from 7 databases and sources, as shown in Table I for the analysis. There was no limitation on the articles' year of publication, considering that

RPA is relatively a new field of research. Limiting the year of publication on the searching criteria would significantly reduce the number of retrieved articles. A similar situation was applied to the keyword used in the searching mechanism. It used a general searching string as follows, Title: "Robotic Process Automation" OR Abstract:" Robotic Process Automation. The "digital transformation" term as part of the research was utilized not in the searching mechanism but in the PRISMA screening process (Liberati et al., 2009) as explained in the following detail of this article.

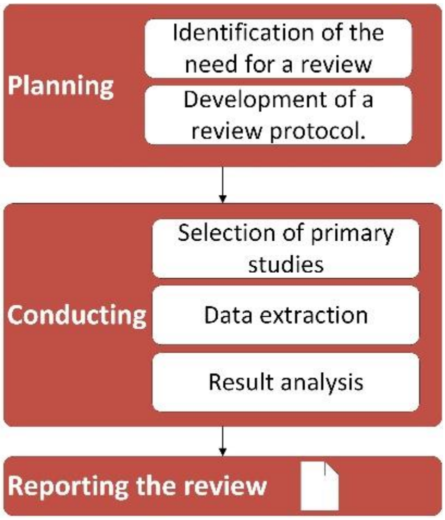


Fig. 1: Kitchenham procedure for systematic literature review

Table 1: Number of retrieved articles

Database / Sources	Number of Retrieved Articles
IEEE Xplore	75
ACM Digital Library	6
Science Direct / Elsevier	19
Proquest	19
Springer	82
Scopus	153
Web of Science	169
Total	**504**

The number of documents retrieved from all databases and sources was 504. We removed 213 duplications, and then 291 unique documents remained. This duplication was mainly caused by the searching conducted in the Scopus and Web of Science (WoS) databases. Most of the articles have been indexed by Scopus and WoS; hence many duplications were found. The PRISMA screening process (Liberati et al., 2009) was adopted to screen and analyze the article one by one based on their Title and abstract, as shown in Figure 2.

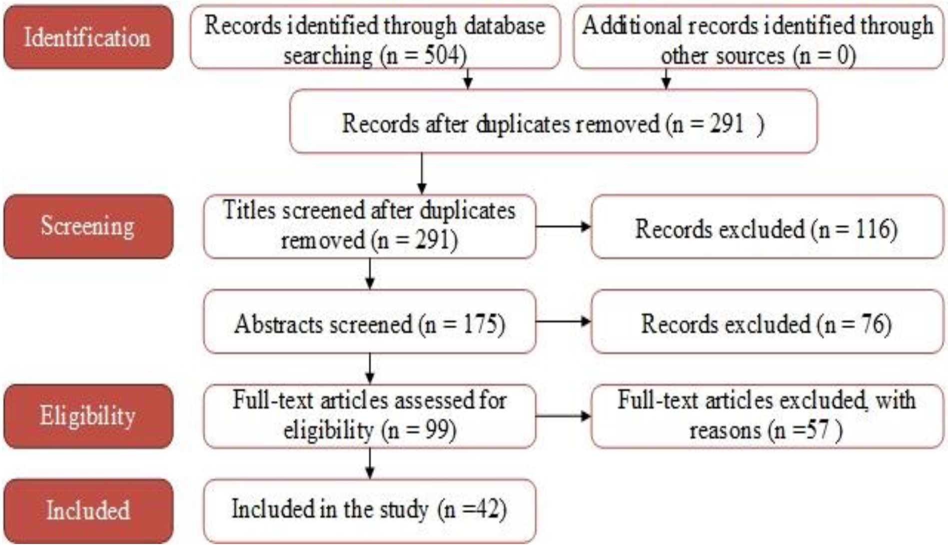
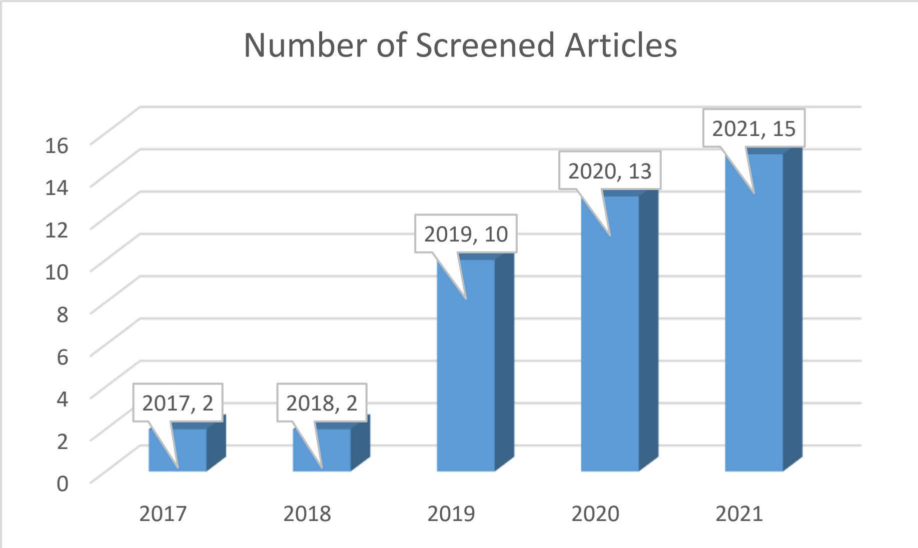


Fig. 2: The article screening process diagram

Based on its Title, 116 articles were excluded; hence 175 remained. The abstracts of 175 papers were then evaluated. Seventy-six articles were excluded based on the abstract so that 99 articles are eligible to be fully-text reviewed. Finally, 42 articles were included in the study and analysis.

Figure 3. shows the distribution of articles based on the year of publications. The result shows that RPA is relatively a new technology as the earliest publication included in this study was in 2017. The number of articles constantly increased every year. Most articles were published in 2021. It indicates that research in this area is growing up.

Fig. 3: Article distribution based on the year of publication



3. Result and Discussion

3.1. The trends and relations between RPA and digital transformation

The trends and relations of RPA to DT were identified by creating three different bibliometric analyses. A network map based on the article's keywords co-occurrence was created by utilizing VOSviewer (van Eck & Waltman, 2010) software, as shown in Figure 4. We drew all of the relations among 330 keywords from all of the articles, as shown in Figure 4. There are 5 clusters represented by five different colours, i.e. Red, Green, Blue, Yellow, and Purple. The clusters were created based on the distance among the keywords within all included articles. It means that all the items categorized in the same cluster have a closer distance to each other than the other items outside the cluster. RPA and DT are placed in the same green cluster with green colour, as shown in Figure 4. These two items are interpreted to have a close relation. It means that RPA has some roles in the DT initiatives.

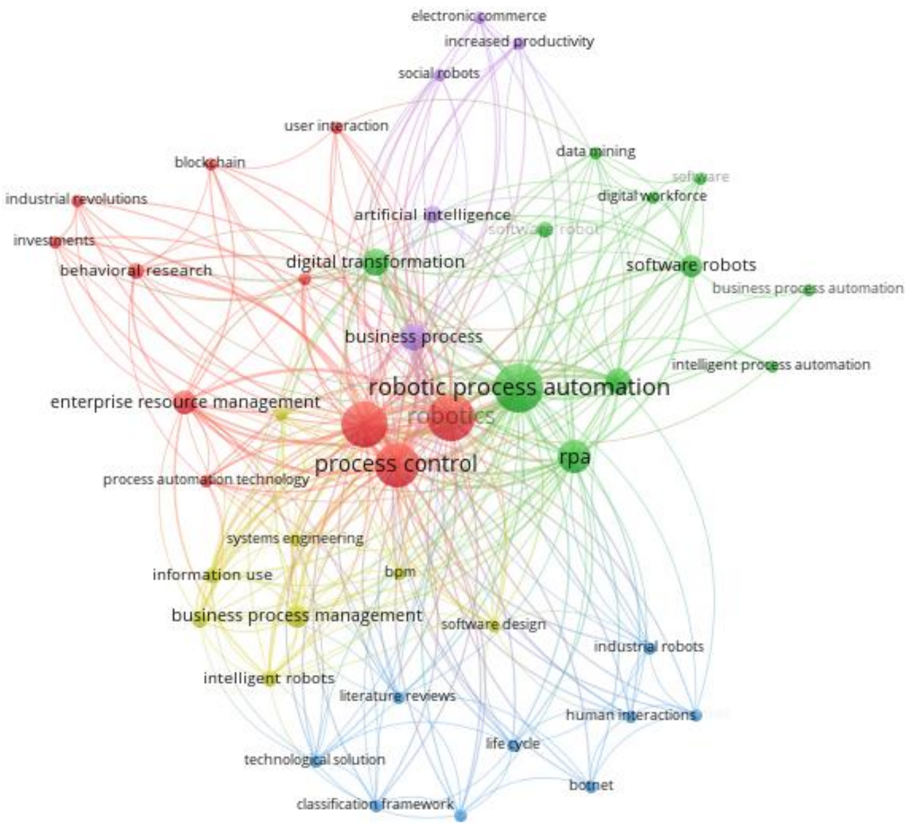


Fig. 4: Network map based on keyword co-occurrence

RPA is considered an important technology to be utilized in a DT initiative. RPA and DT have some relations with the other items such as business process, process automation, business process management, process control, the industrial revolution, digital workforce, and information systems. These items are considered the main topics in RPA and DT research fields until today. Table 3 shows the detail of items in every cluster.

Table 2: Items in every network map cluster

Cluster	Items
Cluster 1 (Red colour)	Blockchain, enterprise resource management, industrial revolutions, investment, process automation, process automation technology, process control, research opportunities, robotics, user interaction.
Cluster 2 (Green colour)	Automation, business process automation, data mining, digital transformation, digital workforce, intelligent process automation, robotic process automation (RPA), software robots.
Cluster 3 (Blue colour)	Botnet, classification framework, human interaction, industrial robots, life cycle, literature reviews, personnel, technological solutions, theoretical foundations.
Cluster 4 (Yellow colour)	Business process management (BPM), information system, information use, intelligent robots, machine learning, software design, system engineering.
Cluster 5 (Purple colour)	Artificial intelligence, business process, electronic commerce, increased productivity, social robots.

More specific overviews of RPA and DT networks to other areas or items are shown in Figure 5 and Figure 6.

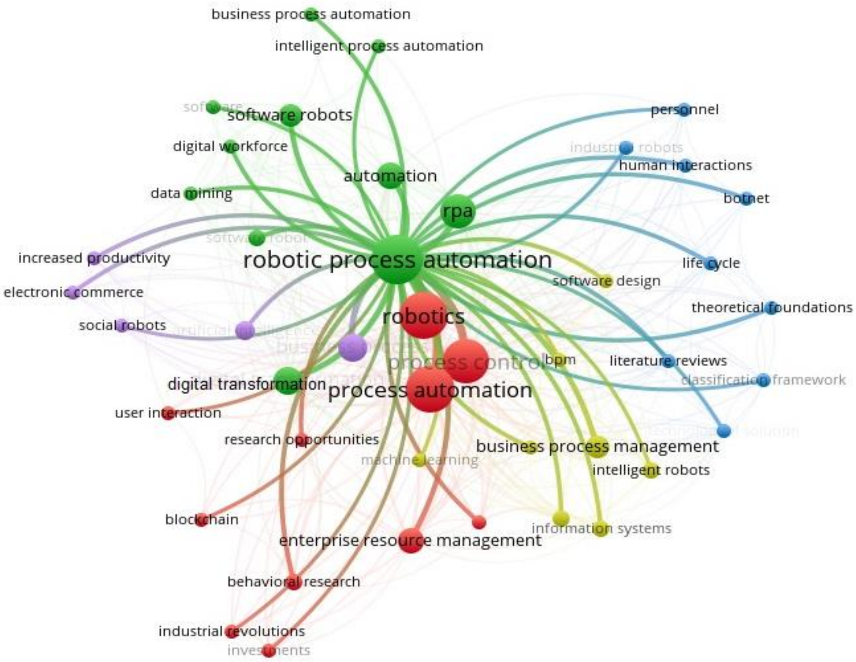


Fig. 5: Network map of robotic process automation

Robotic Process Automation is connected to 43 items such as digital transformation, digital workforce, data mining, business process automation, intelligent process automation, business process management, enterprise resource management, increased productivity, and the rest 35 items, as shown in Figure.5.

On the other hand, digital transformation is connected to 22 items such as robotic process automation, robotics, process control, automation, digital workforce, business process management, the industrial revolution, software robots, data mining, artificial intelligence, and other items shown in Figure.

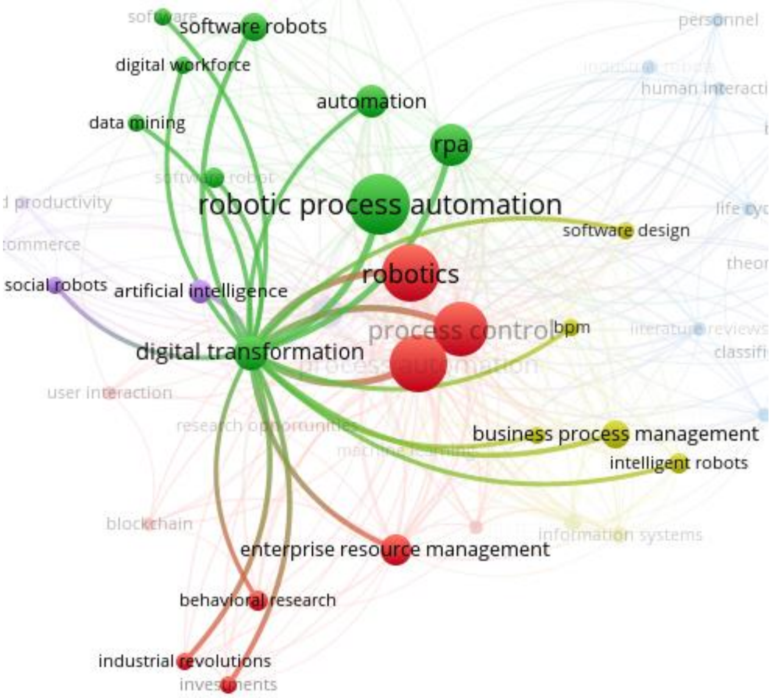


Fig. 6: Network map of digital transformation

We conducted the second analysis to create the strategic diagram and the research evolution of RPA in DT from 2017 to 2021. A strategic diagram consists of four quadrants showing its characteristics and themes toward the trend of current research in particular areas (Cobo et al., 2011). It was created using SciMAT (Cobo et al., 2011) science mapping software. Figure 7 shows the classification of those quadrants. This strategic diagram will give an overview of the contribution and characteristics of every theme or keyword in the articles.

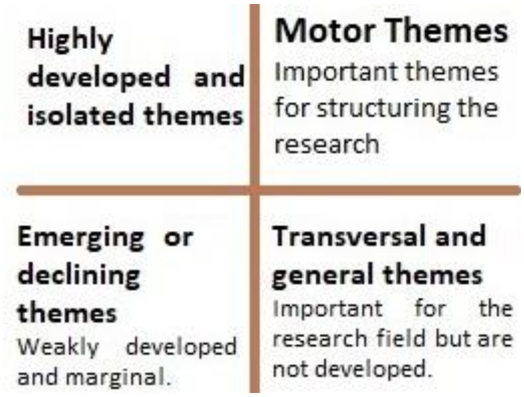


Fig. 7: The strategic diagram quadrants (Cobo et al., 2011)

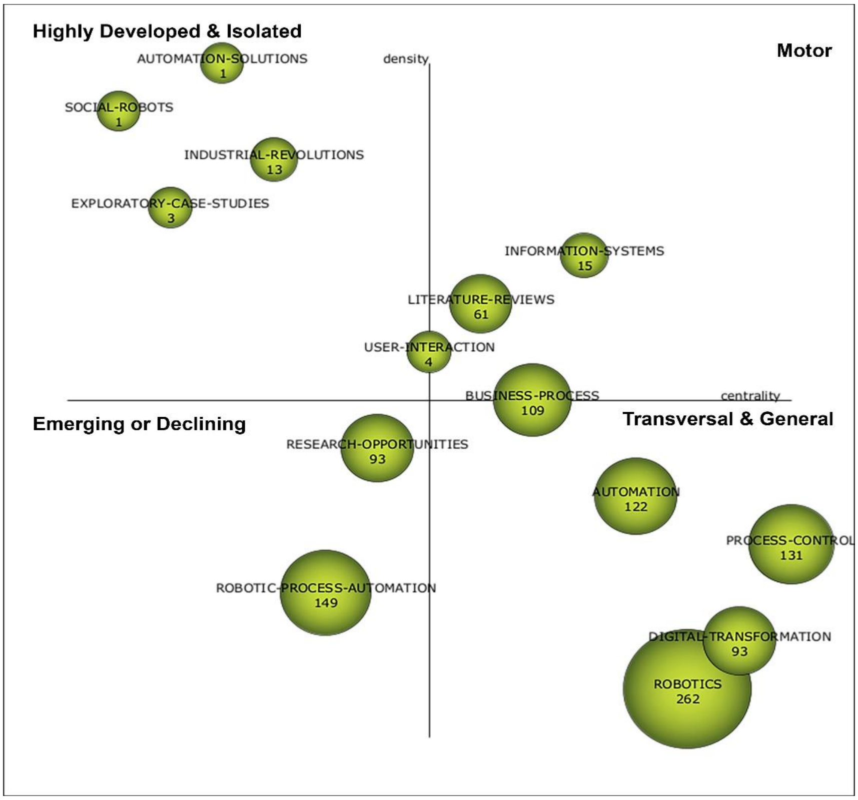


Fig. 8: Themes' position in the SciMat strategic diagram based on document citations

This strategic diagram shows that RPA is located in the emerging or declining quadrant, as shown in Figure 8. Themes located in this quadrant can be emerging or, on the other hand declining themes. We concluded that RPA is an emerging research theme. The reason can be seen from the evolution map of RPA and DT as shown in Figure 9. This evolution map shows that RPA has emerged from 2017 and consistently appears every year until 2021. This emerging condition is also strengthened by the number of increasing research papers every year, as shown in Figure 1. However, RPA is considered to be weakly developed. The main reason for this condition is that it is relatively a new technology. Hence, chances to contribute to research in RPA and its emerging process are widely open.

The digital transformation area is located in the transversal and general quadrant. In terms of RPA research, the DT theme was not found yet between the 2017 to 2020 periods. DT appeared as an important theme to construct research exactly in 2021. It appeared in a transversal and general quadrant, which means it is important to construct the research but not developed yet.

We created a research evolution map to give an overview of the research evolution of RPA in DT. This research evolution of RPA in DT can be seen in Figure 9.

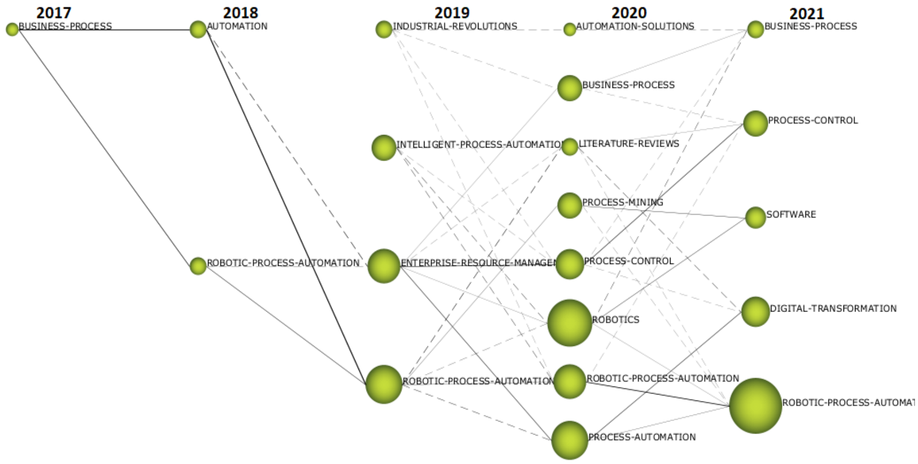


Fig. 9: Research Evolution of RPA for DT from 2017 to 2021

In 2017 and 2018, the research in RPA was mainly about business processes and automation. RPA is tied up with the issues on how to automate and improve the business process performance. In 2019, people talked about RPA for industrial revolutions, intelligent process automation, and enterprise management. The technical themes about RPA occurred in 2020. It is mainly talking about automation, business process, and process mining. The research themes were thriving up until 2021. Digital transformation and all about process or process control were taking place in 2021. In this year, many researchers contributed to the use of RPA in digital transformation. However, it does not mean that the RPA in DT research did not exist in the previous years. It shows how the DT theme was gaining more attention in 2021. The reason is probably because of the coronavirus pandemic, which forces many organizations to initiate DT. The DT was expected to give benefits to many enterprises.

Based on the strategic diagram and the research evolution that has been described above, we drew some conclusions as follows. RPA is a new research area, starting to be acknowledged in less than a decade. This new technology is emerging and gaining more attention, including RPA in the digital transformation research. RPA is mapped to be an important theme if we talk about digital transformation initiatives. Therefore, researching this area is expected to give many contributions practically or theoretically.

The Roles of RPA in A Digital Transformation Initiatives

As illustrated in Figures 2, 3, and 4, RPA has a relationship with digital transformation and other themes such as business process management (BPM), process automation, digital workforce, automation solutions, and process control. It can be concluded that RPA plays some essential roles in the DT project initiatives. First of all, RPA plays the role of an orchestrator of the existing systems in the enterprises. It is placed on the top of the current systems. RPA will navigate other systems such as ERP and CRM and act as a “digital worker” (Kossukhina et al., 2021) to perform tasks usually carried out by humans. Based on those characteristics, implementing RPA doesn’t require changing the previously existing systems. Therefore, it will save cost and can be implemented relatively faster than any other DT technology (Van Chuong et al., 2019), (Hofmann et al., 2020).

When a company decides to take the DT initiatives, RPA is expected to give full value creations quickly and minimally. It is expected to provide many competitive advantages, such as improving and leveraging the business process performance. Thousands of firms have experienced the improvement of their business in numerous business process domains by implementing RPA (Kirchmer & Franz, 2019), (Ratia et al., 2018), (Flechsig et al., 2019). RPA will reduce the processing time by executing tasks flawlessly with minimal interruptions and human error (Ketkar & Gawade, 2021; Timbadia et al., 2020; Viale & Zouari, 2020). As we know, human workers will most likely not resist interruptions, distractions, and errors when performing their jobs. All the tasks which RPA performs are also traceable (Hofmann et al., 2020). Hence any anomaly can be detected relatively fast and easily. It reduces the risk of data and information security issues such as information leaks or theft(Maalla, 2019).

At the top of its role, RPA will transform the business process to be more agile, effective, scalable, and efficient (Ketkar & Gawade, 2021). Agility is an important characteristic for companies dealing with rapid and inevitable business disruption(Aguirre & Rodriguez, 2017; Kirchmer & Franz, 2019). RPA will eventually lead to customer satisfaction by performing process compliance; therefore, financial performance will also be improved (Schmitz et al., 2019). We have created a pyramid chart, as shown in Figure 10 to summarize the roles and RPA impacts in the enterprise.

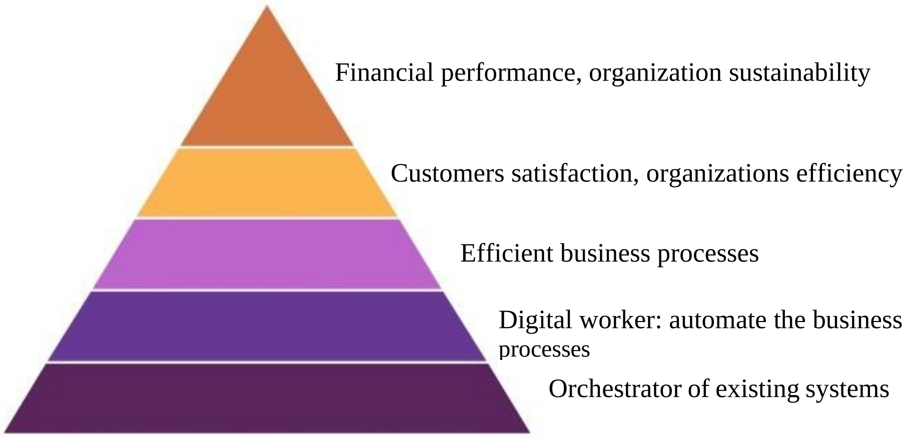


Fig. 10: Pyramid chart of RPA's roles

3.2. Area of Implementation and available RPA software

RPA has been implemented in many fields and areas, ranging from e-government (Ramadhan et al., 2012) to health care systems. Our study found three most common usage of RPA are in the financial service and banking (Kedziora & Penttinen, 2021; Leshob et al., 2018; Met et al., 2020; Romao et al., 2019), taxation, accounting, and auditing (Dehnert, 2020), (Kokina & Blanchette, 2019), (Gotthardt et al., 2020), and automotive industry (Gotthardt et al., 2020; Wewerka & Reichert, 2021, 2020). Other areas of implementation are shown in Figure 11. drawn based on (A. George et al., 2021; Kajrolkar et al., 2021; Lacity & Willcocks, 2016; Ratia et al., 2018; Razak et al., 2021; Schmitz et al., 2019; Sharma & Guleria, 2021; Sobczak & Ziora, 2021; Sullivan et al., 2021; Vajgel et al., 2021; Viale & Zouari, 2020; Yamamoto et al., 2020).

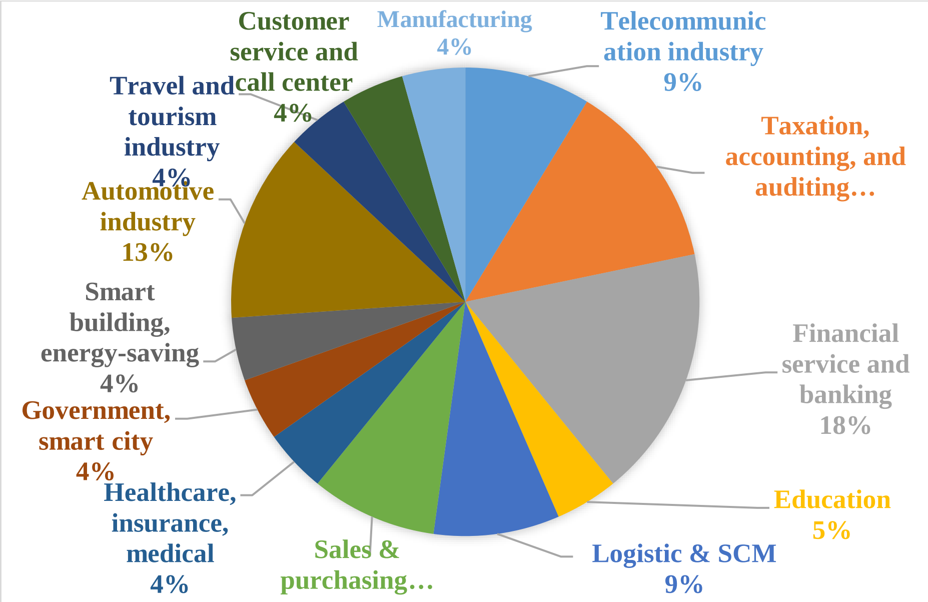


Fig. 11: RPA implementation areas

There are approximately 60 RPA software have been identified in the market. However, only 18 RPA software have been used widely (*Magic Quadrant for Robotic Process Automation*, 2021), (Balakrishnan et al., 2021), (Agostinelli et al., 2019). Based on the Gartner magic quadrant (*Magic Quadrant for Robotic Process Automation*, 2021), RPA software is categorized into four groups, i.e., leaders, visionaries, challengers, and niche players. All the RPA software in those categories are summarized in Table 3.

Table 3. RPA Software Available in The Market

Categories	RPA Software
Leaders	UiPath, Automation Anywhere, Microsoft, Bluprism
Visionaries	WorkFusion, Pegasystems, Appian, Servicetrace
Challengers	NICE, EdgeVerve Systems
Nice Players	SAP, IBM, NTT, Samsung SDS, Nintex, Kryon, Cyclone Robotics, Laya

UiPath, Automation Anywhere, Microsoft, and Blueprism are the market leaders in RPA software. UiPath is considered the best RPA software because it has an open platform and good visualization (Kajrolkar et al., 2021). Moreover, it gives a free version for user to create their automation.

3.3. Factors determine the success of RPA in the digital transformation initiatives

Researchers have shared some best practices for successfully implementing the RPA. Here are some best practices that should be considered when implementing RPA. Proper business process hierarchy and standardization (Desai, 2020) are critical. In this case, the role of a business analyst is crucial. They have to create a business process maturity model and business process standards. Well-defined and immutable business processes are the critical factors in the adoption of RPA (Viale & Zouari, 2020). Employee skills and competencies are also necessary for a successful digital transformation journey (Peter et al., 2020), (Vial, 2019). Some skills needed have been summarized by (Siderska, 2021) on their survey are database technology, data mining, data analytics, and text mining. Knowledge of artificial intelligence, machine learning, and businessine intelligent such as in (Hayardisi et al., 2018) will also benefit the employees. One more critical issue to successfully implementing RPA is the involvement and leadership of the higher-level management (Viale & Zouari, 2020). Higher-level management plays the role of the decision-maker, including on the financial and resources considerations(N. Afriliana & Gaol, 2014).

3.4. Suitable business processes for RPA implementation

According to (Choi et al., 2021; Fung, 2013; Lacity & Willcocks, 2016; Leshob et al., 2020; Siderska, 2020; Timbadia et al., 2020; Viale & Zouari, 2020), the following attributes are essential to determine whether processes and tasks are suitable or not suitable for the automation process. These attributes can also be considered as part of the success factors for RPA implementation.

- Unambiguous rules because robots require precise instructions to produce correct decisions.
- Limited exception handling, if the three are a lot of exceptions from the processes, most likely it is impossible for the process to be automated.
- High and predictable volumes of processes to control the system performance. In most cases, a low transaction volume makes it difficult to justify the investment from a commercial standpoint.
- Operated in a stable environment.
- Able to access multiple systems. It will reduce labour costs and time spent on the process; hence RPA installation will play a vital role.
- Low cognitive requirements, the current RPA was not designed to perform complicated cognitive processes.
- There should be no requirement to access multiple systems because RPA is put on top of current applications.
- Frequent and repetitive tasks.
- There is no frequent change in the business process
- Processes that have a high risk of human error.

Based on those criteria mentioned above, we concluded that RPA is suitable for digital transformation initiatives. However, it will be effectively run in a rule-based automation system with numerous transactions processing and running in a stable and open IT environment. In some circumstances, adopting RPA might not benefit the company. Those conditions, for instance, are for the company with a lot of manual working steps, complex images such as (Nunik Afriliana et al., 2018), system with an cognitive ability such as autonomus driving ecosystems (Wang & Meckl, 2022) or the company with poor data quality(Nunik Afriliana et al., 2021).

4. Limitations

Regardless of all the contributions, this study has a limitation. It was developed based only on the works that have been published. There might be many works that have not been published yet that can give more visions of how RPA be utilized. Unfortunately, the variety of publications is also limited because this research area is new for academic research. This condition leads to the possibility that the result might be biased in some aspects, for instance, in the case of implementation areas. The result might be different if we conduct a large number of surveys by giving questionnaires or direct interviews with the companies that have implemented RPA.

5. Conclusion and Future Work

RPA technology's trends, roles, best practices, and extent in a DT initiative have been highlighted in this study. RPA is a new and cutting-edge technology for DT journeys. The presence of numerous RPA products on the market, many of which are market leaders, indicates that this technology will continue to emerge in the future years. Many enterprises have already implemented RPA to improve process performance, profitability, adaptability, safety, simplicity, and conformity.

This study has contributed theoretically and practically to the community. Generally, it provides a comprehensive overview of RPA technology related to DT initiatives. Theoretically, the trend of RPA in DT research has been identified based on published work and articles. It gives a baseline for future researchers to start another research, especially on how RPA is positioned in the DT initiatives. This study contributes to increasing the number of research on RPA and DT as it is a relatively new research area. Therefore, it will reduce the business, industry, and academic research gap. Practically, this study provides many insights for the practitioners and enterprises on how RPA can be utilized to enhance their digital workforce. Best practices and success factors have been summarized from some areas of implementation. This study also provides information about the RPA software in the markets with their market leaders.

Eventually, we conclude that RPA plays a vital role in the business and DT initiatives. However, current RPA technology is more suitable for a rule-based automation system. Processes with highly complicated and cognitive characteristics which demand logical cognition, creativity, and frequent exceptions are extremely difficult to automate. In the future, intelligent or cognitive RPA could be a solution to dealing with complex and cognitive processes. Intelligent RPA is an enhanced RPA that employs artificial intelligence, machine learning, computer visions, or natural language processing.

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