The Five Dimensions of Digital Technology Assessment with the Focus on Robotic Process Automation (RPA)

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Abstract: In Technology Management, the assessment of new digital technologies is a challenging process. Most assessments are focusing on cost & benefit. These approaches often fail because main points are neglected. In this paper, the holistic approach of "The Five Dimensions of Digital Technology Assessment" will be described with the example of RPA (Robotic Process Automation). RPA is one of the most promising technologies to save data processing efforts in the office. The Five Dimensions of RPA Assessment is performed by assessing the benefits, technology readiness, usability, company readiness, and the costs that burden the company in the RPA implementation.

Keywords: assessment; benefit; company readiness; cost; RPA (Robotic Process Automation); technology readiness; usability

1 INTRODUCTION

Robotic Process Automation (RPA) is not a physical robot. It is software that mimics human behavior in the interaction with a computer. It performs rule-based tasks such as: sending an email, opening attachments, logging into the application, moving files or folders, filling the form, scarping data from a webpage, extracting data from pdf or images, and so on [1, 2].

In the next few years, the RPA's market share is estimated to increase by 20-30% per year or achieve US$ 2.46 billion in 2022 and US$ 3.97 billion in 2025 [3]. It is in line with the belief that RPA can increase productivity by 86%, quality by 90%, and cost reduction by 59% in the office [1]. Unfortunately, these benefits are not the only factors that consider RPA implementation in the companies. The lack of information about technology readiness, usability, and cost, is still an obstacle for the company to apply RPA immediately [4, 5].

This research will provide information as well as assesses RPA (Robotic Process Automation) with **The Five Dimensions (5D) Assessment** (benefit, technology readiness, usability, company readiness, and cost) which can be used as an initial reference before applying RPA. Using 5D aims to make the RPA assessment process is easier and comprehensive.

2 STATE OF KNOWLEDGE
2.1 Digital Technology Assessment

The implementation of RPA cannot separate from digitization because all automated processes use digital data. When the documents or data are not in a digital form, then OCR (Optical Character Recognition) and additional features need to be embedded. Similar to other digital technologies, the RPA must be assessed carefully. Hence, this research will conduct an objective and comprehensive RPA assessment using the Five Dimensions (5D) Digital Technology Assessment, which focuses on benefits, technology readiness, usability, company readiness, and costs (see Fig. 1).
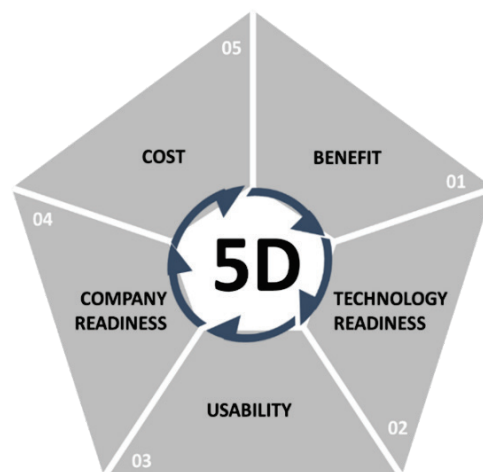

Figure 1 5D Digital Technology Assessment

- **Benefits** are the efficiency of working hours, the reduction of cost, customer satisfaction, and others.
- **Technology readiness** is the readiness of new technology is reflected by technology development and market expectation (Gartner Hype Cycle).
- **Usability** is the understandability, learnability, and attractiveness of new technologies, as measured with the need for internal and external experts.
- **Company readiness** is the efforts for preparing organization, people and data, before new technology implementation.
- **Cost** is the direct cost for investing, operating, and maintaining new technology such as software licenses, installation, custom development or additional feature, compatible hardware, electricity, employee salaries, maintenance, web hosting, server rental, and others.

2.2 Robotic Process Automation

The Industrial Revolution 4.0 is a combination of a physical and digital system that changes the way humans live. It is supported by various technologies such as; the

Internet of Things, Automation, Simulation, Big Data Analytics, Vertical & Horizontal Integration, Augmented Reality, Cloud Computing, Additive Manufacturing, and Cyber Security. I4.0 uses the principles of Interoperability, Modularity, Service Orientation, Real-Time Capability, Decentralization, and Virtualization [7].

In the context of automation, the area consists of automation in the offices and factories. The development of office automation is not as fast as automation in the factory. Since 1980, the factory's degree of automation has risen by 75%, while automation in the office just increased by 3 % [8]. Currently, there are several office automation technologies. One of the most promising is RPA, which has a growth rate is around 30% annually [9].

The RPA consists of three types, the attended robot, unattended robot, and the combination of them (hybrid robot). The attended robot works directly on the user's computer and acts as a personal assistant, thus requiring the user to trigger or start the process. In contrast, unattended robots work on the company's server and run without or less human interference. The hybrid robot is a combination of attended and unattended robots [2].

There are three major RPA providers currently on the market; UiPath, Automation Anywhere, and Blue Prism [10, 11, 12]. **UiPath**, or the previous name "DeskOver," was established in 2005 in Bucharest, Romania. It develops an efficient, robust and stable, robotic workforce controlled anytime and anywhere (cloud-based) [13, 14]. **Automation Anywhere (AA)**, or the previous name Tethys Solutions, LLC, was founded in 2003. It has operated more than 1.5 million bots (bots are the other name of RPA robot) in 20 countries [11]. The latest version of this software is Automation Anywhere Enterprise A2019, which uses a web or cloud-based platform and IQ bots as the artificial intelligence feature to recognize documents. **Blue Prism** was developed in 2001 in Warrington, United Kingdom. The initial goal of Blue Prism was to eliminate manual data entry processes with low returns and high risks. Blue Prism currently offers intelligent and responsive bots that handle various data types in the complete automation process [15, 16].

The advantages of RPA, such as increased efficiency, productivity, and accuracy, have been described in previous studies [1, 2, 4, 10]. Unfortunately, those have not immediately attracted the companies. One of the obstacle factors is a lack of knowledge about RPA and its future opportunities [5]. Therefore, this study will provide objective information about RPA and how to evaluate it.

3 RESEARCH METHODOLOGY

The research will use two methodologies, a literature study, and an expert interview, to answer the following research questions (see Fig. 2):
- What is 5D Digital Technology Assessment?
- What is Robotic Process Automation?
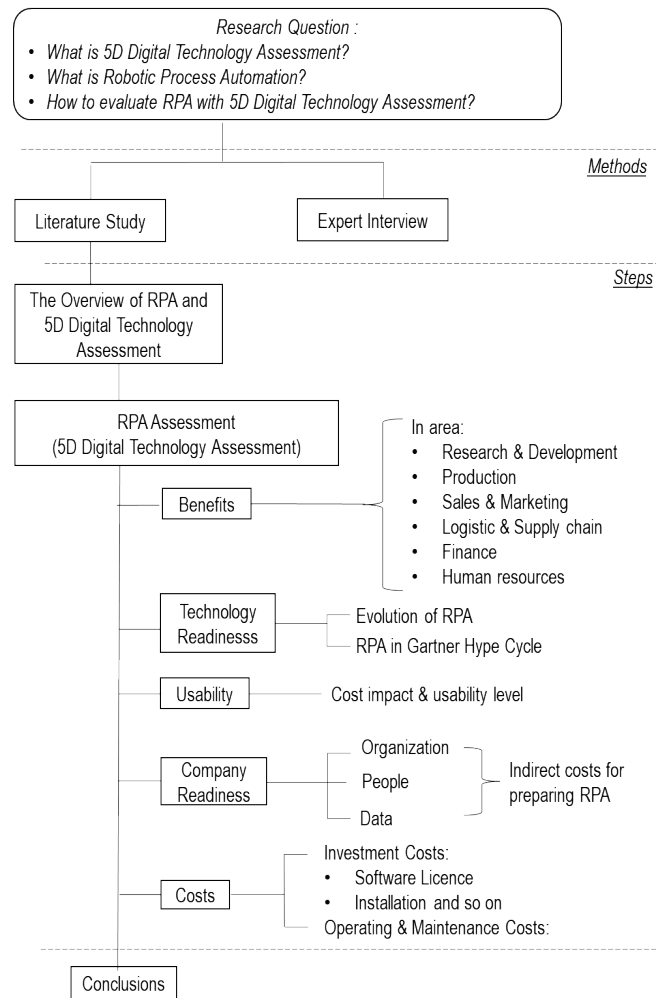- How to evaluate RPA with 5D Digital Technology Assessment?

Figure 2 Research Methodology

The research begins with gathering information related to 5D Digital Technology Assessment and RPA, such as; how they look, their development over time, etc. The assessment process will be started by assessing the benefits of RPA, which aims to build company motivation and confidence in applying RPA. The Benefit assessment will capture all areas where RPA is potentially implemented, such as Research & Development, Purchasing, Production, Sales & Marketing, Logistic & Supply chain, Finance, and Human Resource Department. After that, the research will assess the technology readiness, which includes the development of RPA over time and its position in the Gartner hype cycle (GHC).

The usability assessment aims to see how much internal and external assistance is needed in the RPA implementation. The company readiness assessment is carried out by capturing the indirect costs to prepare: organization, people, and data before implementing the RPA. At the end of the RPA assessment, we will measure the cost dimension, which consists of direct investment costs, operational costs, and maintenance costs that arise when the RPA is implemented.

Table 1 The Benefits of Robotic Process Automation (in General)

| The Benefits of Robotic Process Automation	
Area	Benefits
Research & Development	**Tangible:** • Optimize patent research & collect information about new technology that will be embedded in the developed product [19] **Intangible:** • Increase engineer or designer motivation & creativity by freeing them from routine tasks such as patent research.
Purchasing	**Tangible:** • Optimize invoicing process • Automate bidding & on-boarding process of new supplier [20] **Intangible:** • Increase supplier & prospective partner satisfaction by accelerating invoice, bidding, and on-boarding process.
Production	**Tangible:** • Manage BoM (Bill of Material) • Automate the planning or reporting process of production activities, material requirements, and so on [21] **Intangible:** • RPA was freeing employees from routine workloads such as writing production reports.
Sales & Marketing	**Tangible:** • Collect data on customer preferences and market trend • Automate recording process of customer data & improving customer relationship management [22] **Intangible:** • Increase customer satisfaction by 24/7 customer service • Increase & maintain company's image and reputation
Logistic & Supply chain	**Tangible:** • Manage inventory data • Automate recording process of delivery (incoming material and outgoing products) [23] **Intangible:** • Freeing employees from routine workloads such as entering data of inventory
Finance	**Tangible:** • Automate the reporting and updating process of the treasury, general ledger, and taxation. • Automate the employee payment process (payroll) [24] **Intangible:** • Avoid corruption through a transparent and accountable budgeting process.
Human Resource Department	**Tangible:** • Facilitate the on-boarding process of prospective employees [25] **Intangible:** • Avoid nepotism through a transparent and accountable recruitment process

4 5D - 1st STEP: BENEFIT

The benefits are cost savings, efficiency, and all the stakeholders' advantages due to the new technology implementation [17]. It can be tangible and intangible. The tangible benefit is a benefit that can be measured by a number, such as; increasing process time, reducing costs, smoothing cash flow, increasing income, improving quality & accuracy process, etc. While intangible benefit is a benefit that can be felt but difficult to measure by monetary outcomes, such as; increasing customer satisfaction, increasing employee motivation & creativity, growing market share, improving the reputation of a company brand, and so on [17, 18]. The implementation of RPA brings tangible & intangible benefits in many areas of the company (see Tab. 1).

Assessment: The decision to start RPA must be in line with the company's plans & strategy to reduce labour efforts in the office. The Table above informs companies about the potential benefits of RPA implementation. However, please keep in mind that the magnitude of benefit depends on selecting tasks /processes that will be automated. RPA is more significantly beneficial if the automated tasks/processes have high repetition and added value.

5 5D – 2nd STEP: TECHNOLOGY READINESS

In the initial phase of RPA (RPA 1.0), The Assisted Robot automates various tasks or processes on an individual desktop to reduce process times, save cost, and improve accuracy. Unfortunately, the assisted RPA still requires human intervention in real-time operation [26]. In the second phase, or RPA 2.0, robots are installed on multiple desktops, which run without or less human intervention. The robots will automatically log into the specific computer, start the operation, observe the progress, and stop the operation. Those steps are controlled in the dashboard, which provides several windows for assigning tasks, changing destinations & queues, and reacting to robot output (if necessary). The third phase, or RPA 3.0, is cognitive RPA that uses artificial intelligence, machine learning, computer vision, and natural language processing to carry out long and complex tasks through intelligent end-to-end processes (see Fig. 3)[26].
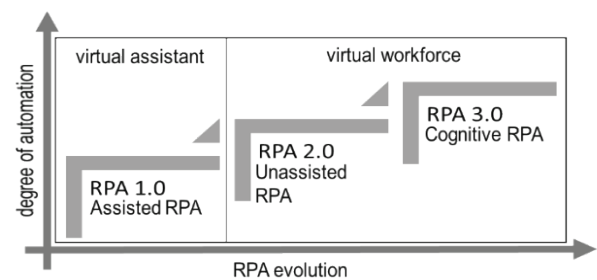

Figure 3 RPA Evolution [26]

Gartner Hype Cycle (GHC) is a brief overview of market expectation and perceived value of the new technology and innovation. It was introduced by Gartner Inc. in 1995 and updated every year as development technology and changing market expectation. Currently, 90 GHC has described various technology such as AI, digital marketing, advertising, and others [27]. Figure 4 shows a modification of GHC with five different areas from "1" to "5". The Intense grey color depends on the length of introduction time & the risk of failure. The darker grey means the longer introduction time and the higher risk to apply new technology.

At the beginning of the cycle, market reactions to new technology varied from less attractive to euphoric. An

increasing market share usually follows euphoria. It happened at the first presence of RPA to the market, until 2018. At the time, RPA was "booming", and its position lies on the "Peak of Inflated Expectations" (see Fig. 4). People think of RPA as an office automation technology that promises full automation services with versatility and user-friendly. However, that is wrong, and the people were disappointed because RPA is not fully automated. Moreover, it is still unable to recognize physical documents such as hardcopy or handwritten documents. This disappointment has brought the "Trough of Disillusionment" in 2019 (see Fig. 4).

In 2020, Gartner plotted RPA on the way to the "Slope of Enlightenment" (GHC) because of the high expectation of cognitive RPA. The embedded cognitive capabilities such as; artificial intelligence, machine learning, and natural language processing make RPA recognize the physical documents and optimize processes (process mining). The cognitive capabilities are believed, can rise RPA to the "Productivity Plateau" (see Fig. 4).

The cognitive RPA has been adopted by UiPath and Automation Anywhere. The AI skill of UiPath, called AI Fabric, teaches a robot to read and understand different kinds of physical documents in different languages (document understanding feature). It allows robots to interact with screens (computer vision feature) and create dialogues to human-being (chatbot feature). Moreover, the robot is also taught to optimize processes using process mining & task mining features [28]. Like UiPath, The Automation Anywhere also has an artificial intelligence feature called IQ bots [29]. UiPath and Automation Anywhere make RPA ready to use for the fully automated end-to-end process with the AI skill.

Figure 4 The RPA Position in Gartner Hype Cycle[1]
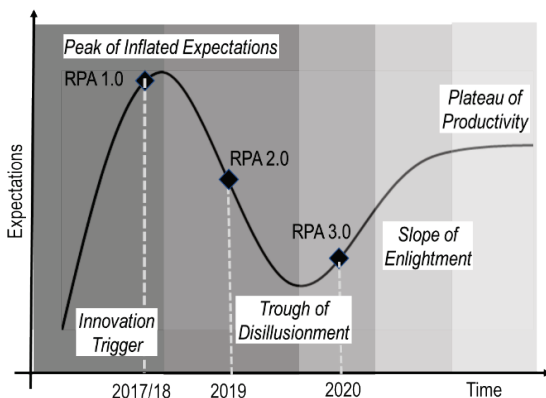
Area	1	2	3	4	5
Introduction time	very long	long	middle	short	short
Risk to fail	very high	high	high	middle	small

Assessment: Implementing RPA when its technology in the area "3" is a wise choice and highly recommended because of the lower risk and shorter introduction time.

However, if the company has core competencies and a large workload in office automation such as online-shop, banking, and insurance company, starting RPA as early as possible or when the technology is still in the area "1" will increase competitiveness although it is high risk and time-consuming.

Currently, the RPA has reached the "3" area. Hence, today is the right time for all companies to consider RPA as an office automation solution, although RPA's AI skills still need to be improved to reach the areas "4" and "5" (Plateau of Productivity).

6   5D – 3rd STEP: USABILITY

Usability is a broad term that refers to the state where the functions, features, and ways of using technology are easier to understand and learn by the users [30]. The New technology is easy to use when it does not require consultants' and external experts' assistance for installation, operation, and maintenance, thus saving costs (see Fig. 5).
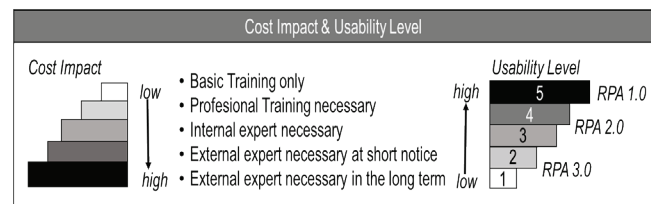
Figure 5 Cost Impact & Usability Level

In the context of RPA, the consultation service includes the advice to select the suitable software, the number of robots that will be deployed, and the potential process that will be automated. An external expert will be hired for programming software and maintenance of the robot's performance during the operation. However, for a company that does not have many robots, those kinds of service and external experts are unnecessary [31]. The consultation cost cannot be well determined because it depends on the specific service and the automated process's complexity. Nevertheless, as a primary reference, the RPA consultant salary in the job market is around US$ 50 - 100/ hour (college graduates in RPA consulting firms) [35, 36]. So, the actual consultation cost can be 300-400 % higher than that.

To make RPA more user-friendly, the RPA providers offer a self-learning module of basic RPA for free. They also provide free software access to community editions. UiPath collaborates with universities worldwide to provide free training for lecturers and students through the UiPath academic alliance scheme. Meanwhile, Automation Anywhere has a similar scheme, called Automation Anywhere University. The RPA tutorials using UiPath, Automation Anywhere, and Blue Prism are also easily found on the internet and YouTube channels. For small companies, UiPath has studio X, which accommodates SMEs' limited skill in applying RPA. Although it is not so powerful as UiPath studio, it is enough to encourage SMEs to use RPA. From the perspective of usability, UiPath is superior to other

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[1] Figure 4 is author's illustration based on Gartner data 2017–20 [39, 40, 41]

providers. It is confirmed by a Gartner study about the leader company in the RPA software market [12].

Assessment: The usability rating depends on which RPA solution we want to introduce: RPA 1.0, RPA 2.0, or RPA 3.0. It starts at the lowest level "1" to "5" as the highest level (see Fig. 5). For **RPA 1.0**, the usability is rated with "5", which has the lowest cost impact. The implementation of RPA 1.0 is relatively easier than others. The users do not need to have a high skill of programming. In RPA 1.0, the companies do not need external experts. The users (employees) who do not have an IT background can learn it through tutorials on the internet and the RPA community (see Fig. 5). **RPA 2.0** is rated between levels 3&4 usability. Advanced training and internal expert assistance are needed because robots work on many computers connected to the servers and corporate networks (see Fig. 5). **RPA 3.0** is rated between 1&2. The company needs external expert assistance because cognitive RPA involves many advanced technologies and knowledge of artificial intelligence, machine learning, and natural language processing. The need for external expert assistance depends on the complexity of the automated process and the number of deployed robots. The RPA 3.0 requires higher costs than RPA 1.0 & 2.0. Nevertheless, it generates higher benefits than others (see Fig. 5).

7 5D – 4th STEP: COMPANY READINESS

In the context of implementing RPA, company readiness is defined as the ability to prepare the organization, people, and data before adopting RPA into business processes. The preparation is related to indirect costs that unwittingly burden. The cost of preparing organizations, people, and data in RPA implementation is relatively smaller than other automation technologies because RPA can be deployed and integrated into existing IT systems (without creating new systems) [2, 11]. However, it depends on which RPA solution we want to introduce: RPA 1.0, RPA 2.0. or RPA 3.0. The integration process of RPA 1.0 is easier than RPA 2.0 and 3.0 because it works specifically on the computer where the robot is installed. Whereas in RPA 2.0 and RPA 3.0, the robots work on several computers and form a network. The network must be controlled and coordinated by an orchestrator. Currently, the RPA orchestrator uses a cloud-based platform, so the robots can be remote-monitored in real-time and deployed across the world.

Table 2 Professional Training Cost [32]

RPA	RPA platform	Price	Duration
Cloud Foundation	Automation-Anywhere Blue Prism Pega RPA UiPath	0 – $160	25-26 hrs
Edureka	UiPath	$350	24 hrs
Multisoft Virtual Academy	Blue Prism	$390	30 hrs
Simplilearn	Automation-Anywhere UiPath	$799-999	36 hrs

RPA training courses play an essential role in educating people to build RPA and provide them with the requisite skills to fulfil RPA initiatives' need. There are a lot of basic tutorials available online for free. Nevertheless, for advanced RPA, there is professional training which costs as seen in Tab. 2.

Assessment: For the company readiness assessment, we made assumptions of costs for preparing organization, people, and data, which need to be verified in the future (see Tab. 3). To implement **RPA 1.0**, the companies do not need to change the organizational structure and process flow because the robot does not replace employee's functions in the organization, and it just acts as a personal assistant who helps individual employees to accelerate his / her tasks. RPA 1.0 does not require a high level of programming skill. One or two days of basic training is considered sufficient to run RPA 1.0, so the training cost and organization cost are estimated the lowest compared to RPA 2.0 and RPA 3.0. In RPA 1.0, the processed data must be structured and digitalized. Physical documents such as handwritten paper cannot be processed, by RPA 1.0, because it just automates data from one application to another, such as the excel file to the ERP system.

In **RPA 2.0**, the organization and process flow are slightly changed because employees' roles are no longer an executor but as administrator or robot supervisor. Therefore, additional training as an administrator is needed. In RPA 2.0, the processed data can be structured but may un-digitized. Physical documents such as paper must first be scanned or photographed before being processed by the robot.

In **RPA 3.0**, the organization and process flow are changed to include RPA experts. The implementation of RPA 3.0 provides excellent benefits for companies, but on the other hand, it also requires expertise to ensure the cognitive robot can run properly. Becoming a cognitive RPA expert requires additional training that is longer than basic and administrator training. The cognitive abilities in RPA 3.0 can process unstructured and undigitized data, such as handwritten documents. RPA 3.0 can also optimize the process by process & task mining features. Thus the organization and process flow can be improved over time.

Table 3 Preparation Cost Assumptions

Preparation	RPA 1.0	RPA 2.0	RPA 3.0
Organization	Organization no change & no cost	Organization need 10 -20 % administrators time	Organization need administrator + experts are hired 1 - 3 month
	$0 - 500 /year*	$5,000 – $10,000 /year*	$ 20,000 - 70,000 /year*
People	Training days: 1-2 days per person	Training days: 1-2 days per person, + 5-10 days administrator	Training days: 1-2 days per person, + 5-10 days administrator, experts 5-15 days
	$0 - 100* /day	$100 - 200* /day	$200 - 500* /day
Data	Only process: digitalized & structured data	Can process: undigitized & structured data	Can process: undigitized & unstructured & data

*author's assumptions

8   5D 5th STEP: COST

The meaning of costs in this chapter is the amount of money that a company spends related to the investment, operations, and maintenance of RPA. The number of costs depends on the RPA type and the process being automated. Logically, the more complicated processes, the higher costs will be incurred.

8.1 Investment Cost

The most prominent component in the investment cost of RPA is the software license. Generally, it is paid once and must be renewed every year. The following is a list of estimated RPA license prices (see Tab. 4).

Table 4 RPA License Price

Vendor	Estimated Pricing
UiPath	It starts at $3,990 per year, per user. There is a free version [33].
Automation Anywhere	For Small Business, starts at $ 750 per month or $ 9,000 /year [34]
Blue Prism	The standard licensing fees are around $100,000/ year for one customer [35]
Microsoft Power Automate	Monthly license cost between $12.60 – $421.50 [36]

8.2 Operating & Maintenance Cost

The Operating costs are considering elements when implementing RPA. Usually, the companies just focus on installation costs and get stuck on operational costs. The Operational costs are needed to scale the RPA in the long run. In 2019, the HFS research stated that only 13% of companies effectively scaled their office automation [37]. Most RPA providers quote an average total operating cost for one robot of around € 500 per month. With 50 robots, the cost goes up to € 300,000 per year [38].

Table 5 RPA Costs

| Providers	RPA 1.0	RPA 2.0	RPA 3.0
UiPath	Studio X Attended Bot	Studio Pro Unattended Bot Orchestrator	Studio Pro Unattended Bot Orchestrator AI Fabric
	$2,000 – 4,000* /year	$20,000 – 30,000* /year	$30,000 – 70,000* /year
Automation Anywhere	AA2019 Attended bot	AA2019 Unattended bot Orchestrator	AA2019 Unattended Bot Orchestrator IQ Bot
	$2,000 – 9,000* /year	$20,000 – 30,000* /year	$30,000 – 70,000* /year

*author's assumptions

The RPA maintenance costs are highly dependent on the automation scale of the company. The more robots that are deployed, the higher the maintenance cost. In SMEs, the deployed robots are less than large companies so that the internal IT department can carry out the maintenance and supervision tasks. Meanwhile, in large companies, the maintenance and supervision of RPA can be sub-contracted to RPA service providers (outsourcing) because if it is done

alone, the annual cost can be higher up to € 70,000 / officer who supervises 10 robots [31].

Assessment: In the cost assessment, each RPA solution has a different cost figure. To implement RPA 1.0, companies need a software license and an attended bot. As for RPA 2.0, companies need to add orchestrators and unattended bots, so the price is higher. For RPA 3.0, which AI embeds, the price is relatively the same as RPA 2.0 because the latest version or update RPA software (Studio Pro & AA2019), is including cognitive features (AI Fabric & IQ bots) free. The increasing costs of RPA 3.0 occur if the company requires unique and powerful AI features beyond the offered feature by RPA providers, such as Hypatos and others. The cost figure of RPA does not mention by a provider (UiPath or Automation Anywhere) openly on their website because it depends on the complexity of automated process and negotiation with a customer. The following table is an author's assumption which contains the range cost of RPA solution that needs to verify in the future (see Tab. 5).

9   FUTURE RESEARCH PLANS

After understanding RPA and the 5D concept in this paper, future research will lead to RPA's further assessment and further application of 5D Digital Technology Assessment. For the RPA assessment, the study will conduct surveys or interviews to explore the essential requirements of RPA implementation, such as human resources skills, organizational issues, and costs. The respondents will be the companies that have implemented RPA and consulting companies that handle RPA projects. With robust and actual data, the RPA assessment will be more accurate and accountable.
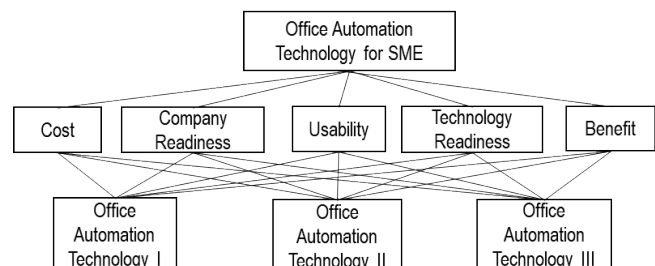
Figure 6 AHP hierarchy in selecting office automation technology for SMEs

For further application of 5D, the research will combine 5D with decision-making tools/methods such as Analytical Hierarchy Process AHP. The case study will focus on selecting office automation technology which appropriate and affordable for small-medium enterprises. The comparison criteria of each technology will refer to 5D (benefit, technology readiness, usability, company readiness, and cost), which defined in this preliminary study (see Fig. 6).

10   CONCLUSIONS

The Five Dimension (5D) Digital Technology Assessment Cycle is a new method that assesses digital

technologies, which cover five aspects: benefits, technology readiness, usability, company readiness, and costs. It is a holistic approach with the target to be easy to use.

Robotic Process Automation is software robots that mimic human behavior in the interaction with computers. RPA is a promising office automation technology.

The target of this paper was to assess RPA with 5D. The assessment shows that RPA has significant potential, and its performance has improved over the last years. However, the introduction of RPA is still time-consuming and cost-intensive. Further research needs to be done to reassess the cost assumptions made in this paper for the 4th Step, "Company Readiness ", & the 5th Step, "Cost ".

Notice

The paper will be presented at MOTSP 2021 – 12th International Conference Management of Technology – Step to Sustainable Production, which will take place in Poreč/Porenzo, Istria (Croatia), on September 8–10, 2021. The paper will not be published anywhere else.

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