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A COMPARISON OF RPA TOOL AND PYTHON PROGRAMMING LANGUAGE FOR A BOM DIGITALIZATION PROJECT IN AUTOMOBILE INDUSTRY

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ABSTRACT

Effective use of technology and digitalization has great importance to increase productivity in today's businesses. Units in the companies can use different digitalization techniques according to their processes and tasks. Robotic Process Automation (RPA) and other software programs are effective tools for digitalization. RPA and Python can prevent people from repetitive and tedious work and allow them to do more meaningful and creative tasks. The motivation of this study is digitalization of one of the most common processes for bill-of-materials (BOM) construction in an automotive company developing passenger and commercial vehicles. RPA and Python tools have been used as a solution for elimination of non-value-added time for mentioned process. Operation steps have been coded with both tools and different work sizes have been tested and compared. The results of this comparison can guide the users to understand which program is more efficient and have better outputs compared to the other one.

Keywords: RPA, Python, Digitalization, Automation, BOM, Automotive

OTOMOBİL ENDÜSTRİSİNDEKİ BOM DİJİTALLEŞME PROJESİ İÇİN RSO PROGRAMI VE PYTHON PROGRAMLAMA DİLİNİN KARŞILAŞTIRILMASI

ÖZET

Günümüz işletmelerinde verimliliği artırmak için teknolojinin etkin kullanımı ve dijitalleşme büyük önem taşımaktadır. Şirketlerdeki birimler, süreçlerine ve görevlerine göre farklı dijitalleşme teknikleri kullanabilmektedir. Robotik Süreç Otomasyonu (RSO) ve diğer yazılım programları, dijitalleşme için etkili araçlardır. RSO ve Python, insanları tekrarlayan ve sıkıcı işlerden kurtarabilir ve daha anlamlı, yaratıcı işler yapmalarına olanak sağlayabilir. Bu çalışmanın motivasyon kaynağı, binek ve ticari araçlar geliştiren bir otomotiv şirketinde malzeme listesi ürün ağacı programındaki (BOM) değişikliklerin yönetimi için kullanılan en yaygın süreçlerden birinin dijitalleştirilmesidir. Söz konusu süreç için katma değeri olmayan zamanın ortadan kaldırılması için çözüm olarak RSO ve Python programlama dili ile işlem adımları kodlanmış ve farklı iş boyutları test edilerek karşılaştırılmıştır. Bu karşılaştırmanın sonuçları, kullanıcılara hangi programın daha verimli olduğunu ve diğerine göre daha iyi çıktılara sahip olduğunu anlama konusunda rehberlik edebilir.

Anahtar Kelimeler: RSO, Python, Dijitalleşme, Otomasyon, BOM, Otomotiv

INTRODUCTION

Today's competitive conditions encourage the companies to find productive solutions using technology and sources more effectively. Spread of digitalization requires using the tools like different software programming languages and robotic process automation programs. Digitalization expresses to convert the owned sources to processes of results which are including value for company. Developing new business models means creating new products and services and harmonizing the processes of using all the sources effectively with technology (Accenture, 2015). Digitalization is the change of business model or converting for new gain and producing value opportunities (Gartner Inc, 2020).

In this study, RPA automation program and Python programming language have been compared in detail and discussed about digitalization of the bill of materials process in automotive company.

The study has standard processes and does not provide added value to the employee when a large amount of workload comes. The process is called "piece movement process" in bill of materials unit of the company. The digitalized process/task includes entering the date and laboratory approval for each part on the bill of materials program according to the requests from the function units of the company. The request forwarded to BOM specialists with Excel file as below Table 1. In this table, the request was forwarded from interior function project specialist to BOM specialist for two parts. Change was related to cost update and was included entering the date and laboratory approval two parts. Requests of this work type generally comes to the unit as large amount and often.

Table 1. Request Excel Form Sample

Model	System	New Number	Present Number	Denomination	Modif. Type	Date	Lab. Sign.	Notes
XYZ	Interior	Not available	1234567	Steering wheel	Cost update	20.08. 2022	No	Not exist
XYZ	Interior	Not available	1234568	Steering wheel	Cost update	20.08. 2022	No	Not exist

The task has been digitalized is repetitive, common usage, has certain inputs and outputs and doesn't need human interference. Therefore, RPA has been used as effective tool for digitalizing of this task. On the other hand, different programming languages has been compared and Python has been selected as second tool because of its advantageous which are listed below.

- Ease of writing coding for employees.
- It has feature to work with different platforms issueless and easily.
- It has a lot of different libraries on it. The bill of materials program used in the unit is opened as an application and is a program with an old/not user-friendly interface. In order to digitalize the program, the Python programming language that works with different libraries, in which screenshots can be used, was preferred. Bill of materials program for digitalization process can integrate with these libraries easily.
- It works faster than the other programming languages.
- Python is popular software programming language. If the engineer or specialist who is not software engineer and developer encounter an obstacle while writing the code, he or she can easily get help from Python community.

The process has been digitalized by using RPA program and Python programming language and compared to guide the users to understand which program is more efficient and have better outputs compared to the other one. Therefore, a person who want to digitalize similar standard work will understand and analyze the tools thanks to this study.

Also, the results have been compared in terms of fast, time and functionality. In the continuation of the study, literature review, then the method, objective, and definitions of the used tools, and in the

conclusion section, numerical comparisons and the details of other comparisons has been explained and detailed.

LITERATURE REVIEW

According to Gartner's dictionary, digitalization means the use of digital technologies to change a business model and provide new revenue and value creation opportunities (Gartner IT Glossary). Generally, digitalization means enabling, improving or transforming business operations, functions and/or business models/processes to get the full benefit of digital technologies and extensive usage and context of digitized data in the business world. Digital transformation, as it is used today, is broader than digitalization as a way to move to digital business (i-scoop). Digital transformation is the holistic transformation of people, business processes and technology elements in order to provide more effective and efficient service and to ensure beneficiary satisfaction, in line with the opportunities offered by rapidly developing information communication technologies and changing social needs. Digital transformation helps companies implement technologies and best practices for faster product creation, enhanced customer experience, and agile business models. These technologies are competent enough to respond quickly to the shift in market trends, customer expectations, and competitors' strategies (Emeritus). Digital transformation tools include virtual reality, cloud system, artificial intelligence, augmented reality. Digital transformation happens when organizations apply digital technologies to their business processes. They use different software programming languages and programs when applying these technologies. RPA is one of the tools that the most widely used to eliminate standard/non-value-added processes. Python is also among of them because of its widespread use, ease and readability, etc.

RPA has great importance in digital transformation. Robotic Process Automation (RPA) is a software technology that makes it easy to automate digital tasks for all users. Software users create software bots that can learn, imitate and then execute rule-based business processes with RPA. RPA automation enables users to create bots by observing human's digital actions (Automation Anywhere). Robotic Process Automation is the use of a new class of software to automate business processes without changing existing information systems. Using RPA software involves, by taking existing or new processes, connecting them to existing applications, and programming them to run on one or more robots as needed (The Journal of Financial Perspectives: Insurance (11-15)). RPA runs using existing core applications for repetitive tasks. This enables people to spend their times for more effective works.

Efficiency, scalability, ease of use, accuracy and flexibility, improved customer experiences are key benefits of RPA. Reducing the non-value-added time and costs lost from repetitive routine work, providing higher customer and employee satisfaction, reducing the errors caused by human errors and accordingly reducing customer complaints due to fast and accurate transactions are among the benefits of RPA (i-scoop).

One of the important programs used in digital transformation is the Python software programming language. Python was developed by Guido Van Rossum in 1991. Python is a platform-independent object-oriented interpretable scripting language with high-level simple syntax, very easy to learn, supporting modularity and readability. Python is one of the most used popular applications today. Python is a fast and powerful programming language. Thanks to the various libraries it contains, it provides the necessary facilities from basic operations to more complex operations. It is a software language that supports other technologies. It is portable because it is used in different operating systems (Windows, Linux, Macintosh, Solaris, iPod, iPhone, Android), it is a platform-independent programming language, it does not require any changes in another program. It provides applications in many fields with its wide libraries. In addition, being an easy-to-use and open-source program is one of the features that make Python programming language advantageous.

Python programming language is widely used by companies in many sectors. Google, YouTube, Pixar, NSA, Dropbox, iRobot, ESRI are examples. Data science, game development, web development, image processing, robotics, autonomous vehicles are the areas where this programming language is used.

Calışkan and Kıran investigated the benefits of robotic process automation in their study. They applied the surveys and interviews to the employees who had done projects with robotic process automation in an automotive company. The surveys and interviews were administered to a certain number of people, considering factors such as technical knowledge, use of the project and role. The questions were formed on the purpose of application of robotic process automation in the company, the areas in which it is used and its benefits. As a result of the research, all participants agreed on the use of robotic process automation in the company and its application in their processes (Çalışkan and Kıran, 2020).

Axmann and Harmoko have discussed the benefits and challenges of robotic process automation in their study and compared them with other technologies in industry 4.0. In their work, they mentioned the attended, unattended and hybrid mode of RPA. They emphasized that RPA can be applied in many departments according to the organizational structure, business process flow and decision-making process of the enterprises. They explained the use of RPA in purchasing, production, sales-marketing and human resources. A Deloitte survey in 2017 showed that after implementing RPA, company efficiency increased by 86%, quality by 90% and compliance by 92%. This shows that it increases efficiency and reduces costs in business processes. They have included the benefits of RPA for companies, customers and employees in their work. As a result of their studies, they emphasized that RPA is suitable as it can increase productivity with low investment costs compared to other industry 4.0 technologies, and that it is easier and faster than other technologies, integrating with processes, systems and other applications, and using existing infrastructures (Axmann and Harmoko, 2021).

Nosrati explained in his study that the Python programming language is a suitable language for both learning and programming. In his work, he also explained the emergence and development of the Python programming language. He emphasized that the Python programming language is a high-level, dynamic, object-oriented, general-purpose programming language that can be used in a wide range of applications, and that it can also support different programming styles, including structural and object-oriented. He addressed the distinguishing features of the Python software programming language, what can be done with this software language, its development, alternatives and complements in his work (Nosrati, 2011).

Rahmany and his friends have compared Python and R for exploratory data analysis (EDA) in their study. They explained purpose and steps of EDA to perform. Python and R most common tools are used to perform EDA. Many libraries (Pandas, Numpy, Matplotlib, Seaborn,Bokeh) in Python are very useful for EDA. R has some packages according to statistics and mathematics to deal with EDA. Data that contain 16 columns and 300 rows has been used to compare R and Python on their study. On the data, they compared analyzing of attribute and univariate data, grasping linkage among attributes, observing suspected pattern, detecting outlier for both programs. As a result of the study, Python and R has useful for EDA (Rahmany et al., 2020).

Foster researched differences of C ++, Java and Python programming languages in his study. He analyzed 3 software languages based on standard evaluation criteria of readability, simplicity, orthogonality, portability, programming environment, and usage cost. As a result of his study, it is obtained many important results. A few of these is Python more readable and simpler language. Also Python and C++ are very useful in their flexibility simplifying programmer-defined abstractions. In addition, Python support multiple inheritance. When comparing the C++ and Java, one of the results is that C++ is used for major projects. Python requires fewer lines of code than C++ and Java. Also, Python is easy-to-learn programming language (Foster, 2014).

Khoirom and her friends made comparative analysis for Python and Java for beginners. They inferred that both programming languages have advantages. Python is simple, readable and easy but Java is also more secure. Python has easy syntax for users than Java but execution time on Python is longer than Java because the exact datatype for variables is known during compilation on Java. They emphasized in their study that person should choose the programming language his/her interest field. If the person is interested in creating games, Java and C, C++ programming languages should be

preferred but for artificial intelligence, web development etc., can be preferred Python, JavaScript, Rubby (Khoirom et al., 2020).

When the literature was searched, no similar study could be found that compares Python and RPA in a specific process.

OBJECTIVE AND METHOD OF THE RESEARCH

According to advancement of technology, companies increase the studies on digitalization for decreasing the human hand errors, increasing efficiency, finding fast and efficient solutions to customer needs. Automation programs which include various software-based programs and software robots are among the main resources of digitalization studies. Applying the digitalization works of the companies to the right business processes based on units and ensure the sustainability of these processes is of great importance for reaching goals. Various work processes can digitalize with RPA program, one of the digitalization tools and Python which is a software-based programming language widely used nowadays. In this article same amount and type of task has been automated with two different programs; Python programming language and RPA program and then their efficiency was compared over outputs. As a result of the study, comparison of tools is expected to be useful for users who want to choose a program while contributing the employees for digitalization of their work processes.

Units in the company can increase the productivity and efficiency with focus on value adding works instead of working on repetitive and tedious work. Companies carry out digital transformation with different technologies and coding tools. Robotic process automation (RPA) is one of the tools used to digitalize tasks done frequently with high volume and long execution time. Automation of work processes with RPA increases efficiency. RPA is a process which includes software robots instead of physical tools. Companies want to automate their works and make them more efficient with minimum change, instead of making many modifications in their systems. RPA programs work in harmony with different systems and can also work with old or different programs already available in company's system. RPA has widespread usage for different industries. RPA programs are appropriate for processes which stick on certain rules, which include digital data, and which are repetitive with high volume and open to human mistakes. RPA programs provide the users effective and practical coding with scripts inside. Thus, users can develop codes for repetitive tasks with RPA. RPA program has substructure which can work with many various softwares, so that users can develop new codes for repetitive tasks which are made of different programs.

Python is a coding tool for different applications and goals. Python has widespread usage on digitalizing processes thanks to its user-friendly interface and flexible coding language. Moreover, it has different usage areas in addition to digitalization of processes. Python can be used for different areas like web applications, desktop applications, game development, mobile applications, network programming, data mining, data analysis, machine learning, artificial intelligence applications, scientific calculation applications and internet of things (IoT). There is a very big data set of libraries in Python for mentioned areas and there are lots of available development tools and open sources which makes it effective to utilize. As a result, Python is being used by many corporate firms such as Google, Instagram and Spotify

The study has been done in the bill-of-materials department of an automotive company and presented to its employees. There is a variety of tasks done within the department which are carried out according to the requests coming from other departments. These tasks contain creating the new bill-of-materials or modifying the current bill-of-materials considering all parts of vehicle systems and according to time-based plans. All the parts are created and managed within a PLM system specific to the company. Some of the requests from the project managers in the units include frequently repetitive and time-consuming process steps. This transaction requests do not add value or benefit to employee who carry out with bill of materials program. The study includes digitalization of one type of transaction which does not create added value and frequently requested from functions in bill-of-

materials department. This operation type which is called piece movement was automated by using Python and RPA tools. Piece movement process is done for cost, logistic and supplier changes instead of physical changes on vehicle parts. As a result of this process, suppliers are informed about the changes other than physical updates. In the BOM program used in the department, vehicle parts have unique part number and the processes are carried out on these part numbers. The part numbers are defined for the models of vehicles. Some processes done in BOM unit are frequent and in large quantities based on the project stages. The piece movement process is requested by the function project chief and forwarded to the bill of materials specialist with an Excel file. The Excel file contains the part numbers to be processed, the vehicle model code and the change request number. BOM specialist checks the Excel file containing the requested information and performs the necessary operations on the BOM program. These processes are done for each part number in the file. If the part numbers are in large quantities, the employee's time is largely wasted for a non-value-added transaction process. In large quantities, this process can lead to human error and demotivate the specialist. The tools have been compared in terms of digitalization and an operation has been created which adds value to the unit with digitalizing of mentioned process in two different tools. As a result, employees started to spend their time more productively thanks to this new digitalized process.

Figure 1. Diagram of Business Process for Both Tools

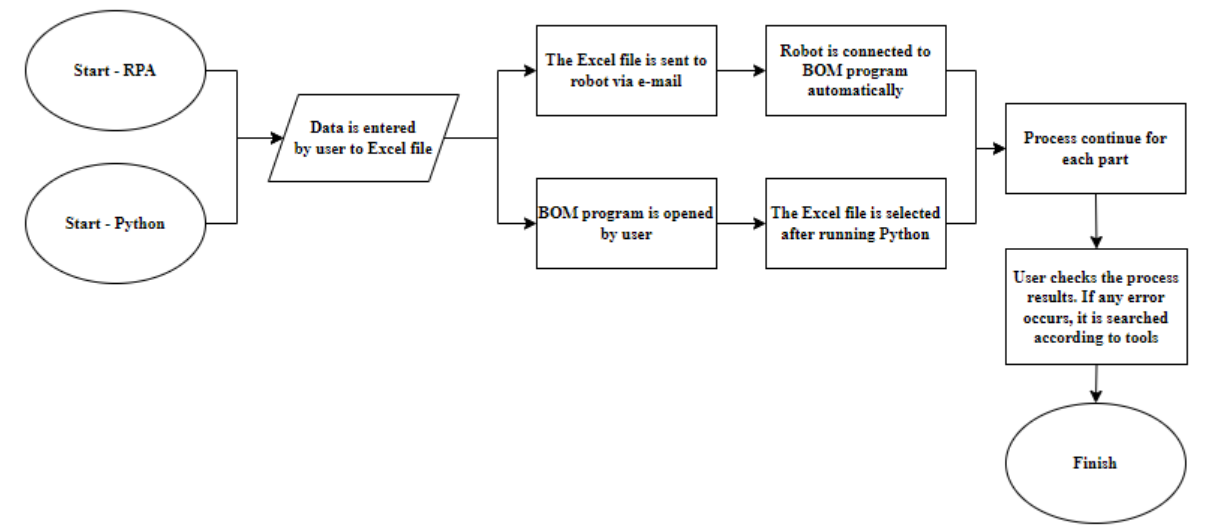
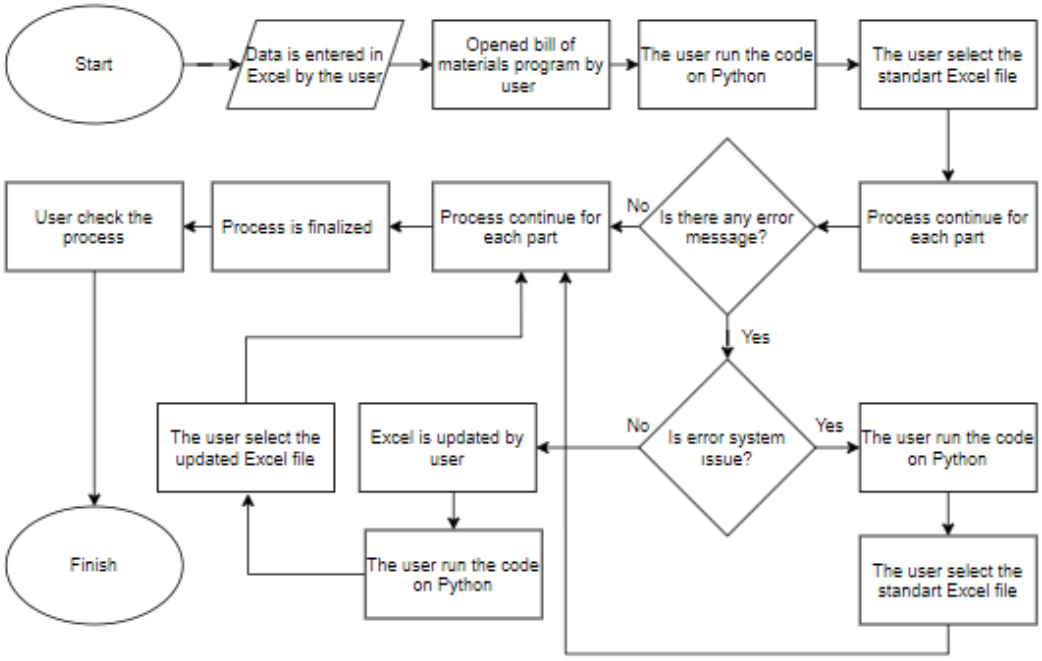


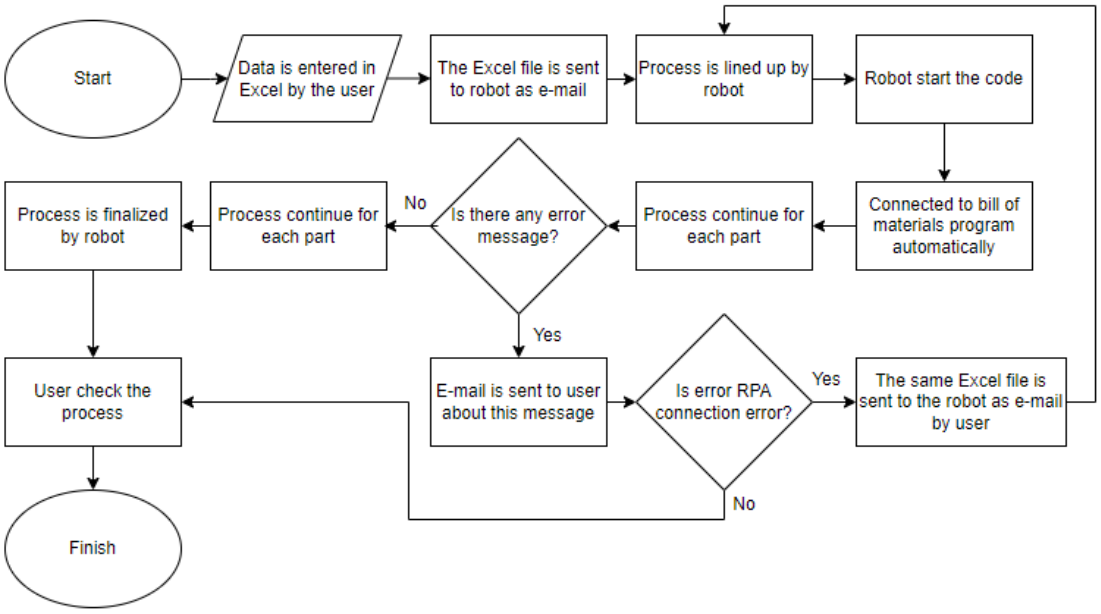
Figure 2. Algorithm Diagram of Business Process Coded in Python



Digitalization of Business Process with Python Programming Language

A standard Excel file was first created for the piece movement process. The Excel file contains the part numbers to be processed, the vehicle model code and the change request number. The openpyxl library was used in the Python programming language to read the Excel file content. When the program is run, the user first selects the Excel file. The tkinter package was used because the Excel file can be in a different location on each user's computer. Therefore, the user can select the file from the any location on the computer. Screenshots of the fields that need to be entered for process were taken in the product tree program for coding, this was done with the pyautogui library. The operation starts with the user first opening the relevant screen in the bill of materials program and then user runs the code by opening the Python, then selects the standard Excel file from the folder that opens on the screen. After this step, mouse control is not in control of the user. The first part number in the Excel file, vehicle model code and change request number are entered in the part number field by using automatic mouse movements in the bill of materials program. Then button on the screen is clicked by the program and information of the part number is open on the screen. The date of the day of the transaction is entered in the field/cell where the date is required. The cell where the material approval is clicked as "No" and then is clicked the save button. The process is repeated for the next part numbers on Excel request file. If any error occurs in Python while running process, the error is analyzed by the user. If the error is a system error, the code is run again. If there is an error caused by the Excel file, the completed part numbers are removed from the standard Excel file, and Excel file is updated, and the code is run again. After the process is completed, the user checks the reports from the system and the study is completed.

Figure 3. Algorithm Diagram of Business Process Coded in RPA



Digitalization of Business Process with RPA

A standard Excel file was first created for the piece movement process. The Excel file contains the part numbers to be processed, the vehicle model code and the change request number. Different from the Python tool, RPA tool enters the bill of materials program automatically. RPA program takes the information of the username and password from standard Excel file. The standard Excel file prepared by the user is sent as an e-mail to the bot of the RPA. The robot queues up all incoming requests by e-mail. When the turn comes to the e-mail sent by the user, RPA starts to work. RPA first logs into the bill of material program with a username and password of the user and starts processing for each part. If an error is encountered while RPA runs the process, a screenshot of this error is sent to the user's e-mail address. The user examines the screenshot of the error. If the error is an RPA connection error, the same Excel file is sent to the bot of the RPA again and the processes are repeated. However, if the error is not due to the connection or the system, the user analyzes the situation on Excel file which includes the feedback of RPA bot. After RPA tool finishes the process, it sends an e-mail to the user that the process is completed. At the same time, there is a standard Excel file in the e-mail content. RPA tool writes “ok” next to each part number in this file, indicating that the process is complete. If the bot of the RPA cannot perform the operation for a part number, “not ok” is written on the Excel file for that part. The user makes the final checks via the bill of material program with the incoming e-mail and the process is completed.

During the digitalization of the study in both programs, some units were contacted, and permissions were obtained so that the study could be carried out effectively. The necessary permissions for Python installation, Anaconda program installation, Exe installation for users to run Python codes on their computers as program, and authorization to run exe have been obtained from IT. Persons who will carry out the digitalization work for RPA have been trained, and as a result of the training, users have been authorized by IT for Automation Anywhere (RPA Software). In addition, for standardization, a standard Excel file has been created to forward the requests of the project chiefs in the functions.

DISCUSSION AND CONCLUSIONS

The BOM program used in unit of the company is opened with a link in the browser. Employees who use the program are given authorization by a username and a password. Any authorized employee can access the BOM program through their computers. After the program is opened, it cannot be connected as web operation and then the program opens as application. The

program is not a convenient program to do more than transactions related to part numbers. In order to obtain graphics using the data on the program and to use the data in digitalization studies, some external programs must be installed. Python is one of the programs used in the unit which digitalizes the processes. Python is a programming language that contains many libraries, and these libraries can perform different functions. The main library used for this digitalization study is the pyautogui library. This library can interact with other programs with keyboard and mouse control. Pyautogui is available for web and desktop applications. It is advantageous to use the pyautogui library as many operations such as saving screenshots, clicking different buttons, printing data, showing warning and message boxes, closing an application, resizing the page, moving the mouse to the desired location and clicking can be done with the pyautogui library. Because the library uses mouse and keyboard commands, the person who works on the computer screen cannot do any other operation. This feature of the library is a disadvantage for the user because it blocks the computer for the duration of the transaction. There are libraries that allow the user to do different operations on the computer while the tool is running, without blocking the mouse and keyboard of user's computer. However, the BOM program used in the company cannot be opened on the web and it must be opened as an application. Therefore, the use of pyautogui was appropriate for the study.

Since completing of the process digitalization with RPA and Python programming language, optimization has been made to code in order to obtain better results on both tools. The program digitalized on Python should be usable by every user in the BOM unit. The digitalized work performs operations using an Excel file. At the beginning of the study, the file extension was given as code in the tool. As the selected file content and location change, the user would have to change the code context. The tkinter library has been used to prevent this problem from occurring on different users' computers. Thanks to this library, users can select files from any location on their computers. In addition, the code written has been converted into an exe program so that each user could use the digitalized work as a program. This conversion process has been done with IT permissions. IT has defined a room to run the exe program on user's computers.

The digitalized work performs operations using an Excel file on RPA. Users log in to the bill of materials program with their passwords and usernames. Passwords and usernames are on sheet of the Excel file to be selected. Therefore, RPA tool can read in a standard way. Instead of RPA, automatic login to bill of materials program has not been written on Python programming language because the user is mostly working on the BOM program on the computer, the program often opens beforehand. In the future, Python codes can be optimized automatically for login into bill of materials program in the case of not running the program on the user's computer.

Table 2. RPA-Python Comparison Chart

COMPARISON	RPA	PYTHON
1-Processing time (based on part number)	★	☆
2-Quantity of part number	★	☆
3-Request response time	☆	★
4-Ease of entry into the program	★	☆
5-Functionality	★	☆

6-User's coding competence requirement	★	☆
7-Ease of access to resources	☆	★
8-Unblocked state of the user's computer	★	☆

Table 3. Total Processing Times

COMPARISON FOR TIME	RPA	PYTHON	PERCENTAGE
Process time for 20-part numbers	15 min	18 min	%20
Process time for 50-part numbers	35 min	55 min	%57
Process time for 80-part numbers	52 min	75 min	%44
Process time for 100-part numbers	70 min.	100 min.	%43

According to Table 1, for 1. and 2. items; in this study, the average processing time of RPA for each part number is 40 seconds. On the other hand, processing time of Python for each part number is 50 seconds on average.

For 3. item, RPA process starts with sending an e-mail to the robot. Robot queues the process, so the processing time depends on the amount of the queue. However, if the user requests to run the process with Python, the user can start the process from the computer at any time. This ensures that the transaction is carried out faster and the customer's demand is met on time.

For item 4, instead of Python, entry to the BOM program is done automatically during RPA processing. Since the bot of the RPA queues the processes, entry codes to the BOM program have been written on RPA. Since the user is mostly working on the BOM program on the computer, the program often opens beforehand. Therefore, there has been no need to write extra code on Python for automatic login to BOM program.

For items 5 and 6, the RPA program is functional in a way that anyone with basic training in this field can use it. The code-writing time is also shorter accordingly. Some operations, such as library installation with Python, require IT support for security reasons and company policy. The process of writing code in Python requires more experience. This affects the digitalization time of the process.

For item 7, access to RPA-related resources and explanations of operation commands is more limited over the Internet. When using the Python to digitalization, it is possible to access many resources over the internet.

For 8. item, in the process made with RPA, the user's computer is not blocked because the robot performs the operation with servers connected through virtual computers for large quantities of parts. When the process is done with Python, it can block the user's computer as the process proceeds using keyboard and mouse movements. Therefore, the user must wait for the process to complete before performing other operations.

The results obtained when the process was run for different quantities and processing times are given in Table 2. These are the average transaction completion times. Also, table shows comparison percent of the processes' velocity. Unstable distribution of the percentages on the table is related to amount of the work queue of RPA and features of the computer.

The type of transaction handled in this study has been digitalized using RPA and Python, and the differences between the two digitalization tools and the advantages and disadvantages of these programs have been explained. It is concluded that RPA is more effective and suitable for the automotive companies than Python. RPA don't block the computer. Since RPA has no effect on the computer, the computer can be used for other business, research and development. In addition, since RPA is a more suitable program for companies in terms of security, its use is more convenient than Python. When requests come from function project chiefs to BOM unit a large amount of workload about the process digitalization, RPA should be preferred by users. Therefore, users' computer doesn't have block.

For the use of RPA, the people who will do the digitalization have been trained and authorization has been defined. RPA programs are licensed programs and people who will receive training to use RPA software must be trained by the company to develop projects that will eliminate non-value-added work. RPA is effective in large amount of workload and these workloads may need urgent completion, but it would be advantageous to have another functional computer so that there is no delay in the completion of the workload because RPA queues the requests that come to it.

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