Service Quotation Generation Using Robotic Process Automation Technology

Agne Paulauskaite-Taraseviciene[a], Vilius Kerutis[b]

[a]Department of Applied Informatics, Faculty of Informatics, Kaunas University of Technology, Kaunas, Lithuania
[b]Faculty of Informatics, Kaunas University of Technology, Kaunas, Lithuania

Abstract

Robotic Process Automation (RPA) is one of the fastest growing segments in the enterprise IT space enabling the automation of repetitive tasks performed by humans. RPA is usually applied to various business processes and activities in sales, customer relationship management, support functions, etc. A service quotation generation (SQG) is a process often used in sales market for creating a service quotation, tracking it, and, after acceptance, transferring it to a service order. SQG can be designed in different ways and for different purposes, but in general it is repetitive and rule based process thus a good candidate for RPA. In this paper RPA approach is proposed for automated service quotation generation. The time-effectiveness of the proposed technology was tested with different amount of tasks (cases). Results obtained through automation are superior more than 2 times to those achieved by human labour.

Keywords

RPA, service quotation generation, robots, SAP, scripting technologies

1. Introduction

Robotic Process Automation (RPA) is a new technology utilising software robots for automation of repetitive back-office processes. It finds applicability across industries and business functions [1, 2]. The main goals of RPA are the following: (1) eliminate the need for a human to work on repetitive tasks; (2) speeding-up a process; (3) remove human faults; and (4) achieve 100% accuracy of a robot. The applications for RPA are numerous and growing every year, but some of the most common RPA tasks include banks and financial operations [3, 4] insurance functions [5], tour enquiries [6] and logistics services [7]. However, the identification of candidate tasks suitable for robotic process automation can be estimated under various features and techniques [8]. The identification of automation degree of tasks described in a textual process description features can be analysed using machine learning techniques [9, 10].

Business Process Model and Notation (BNMN) schemes can be created and later analysed for RPA suitability [11]. Mouse actions and keyboard strokes performed by users combined with a sequence of screen images can be employed to evaluate RPA demand in non-invasive manner [12].

Summarizing all approaches it can be concluded that most important criteria for assessing RPA suitability are – rule based and repetitive process, usually including low-complexity tasks, high transaction volume and availability of digital data [13, 14].

RPA is the fastest-growing enterprise software category, therefore there are numerous RPA tools and approaches available in the market [15, 16]. But choosing one could be a challenge, because they can differ in features provided (drag & drop functionality, text recognition, intelligent automation, scraping solution and etc.), OS support, architecture, platform and cost. Recently, the most popular RPA tools are "Blue Prism" [17], "UiPath" [18], "Automation Anywhere" [19] because of the platform independency, smart technologies and industry type.

A service quotation is a specific document of the service order, which is often used in sales market in order to track it, and, after acceptance, transfer it to a service order. Service quotation generation is a rule based process, not dependent on human judgment, standardized and repetitive, thus it is a good candidate for automation using RPA technologies. To evaluate the process automation effectiveness, this paper presents an RPA approach for automated service quotation generation incorporating "Blue Prism" and SAP scripting technologies. The experiments have been carried out to estimate how stable, faultless and fast the automation process is comparing to a human labour.

2. Service quotation generation process

Service Quotation Generation (SQG) - at a higher level, it is a process where quotations are created from filtered orders (with detailed information) and then sent to the clients. SQG can be designed in different ways and for different purposes. The process of SQG included in this research is described below.

First of all, the whole process has to be separated into smaller sub-processes to reach scalability. It is separated into three sub-processes: "Populate Work Queue", "Main" and "Reporting". The first sub-process loads all filtered sales orders from SAP into the "Blue Prism" control room queue. Only one software robot (digital worker) is required for this task. The "Main" sub-process is responsible for the process logic controls. To ensure effectiveness multiple robots should be involved in this sub-process. Items from the queue are taken one by one and independent quotations are generated. The process automation needs one robot to create a queue, and the particular number of other robots to do all tasks form the "Main" sub-process. The last sub-process "Reporting" stands for storing information related to the current state of tasks. It takes all data from the working queue, reads significant information and makes a report. This report is transferred to human workers who are responsible for operating the robot. To complete all tasks of the "Reporting" sub-process one software robot is required.

After execution, the responsible persons can find all required information about the queue items. For example, it can be identified whether it has been a successful execution or not, which is marked as a green check symbol or a red flag respectively. In case of success, customers only care about execution parameters like quotation number, Purchase Order (PO) number and other quotation related data. Moreover, employees, who are responsible for operating the robot, have to be sure that approved cases are certainly successful and there are no logical mistakes in execution. In the case of an exceptional – unsuccessful operation, exception type must be verified. There are three types of exceptions: *business*, *system* and *internal*. Business exceptions include data errors. For example, if the robot instead of information in e-mail address format gets information with unknown/wrong format, it will be considered as a business exception.

Queue items with business exceptions are non- repeatable because it makes no sense to repeat it as the data will not change. System exceptions are associated with application based errors. For example, if the robot

has to approve his actions by pushing the button, but he cannot do that for one reason or another, it will be a system error. Queue items with system exceptions are repeatable most often, up to three attempts. Internal errors are associated with unpredictable cases, when robots in a certain situation do not know how to behave and consequently have to terminate their job. These errors are visible in the processes management part only. The biggest challenge is to predict all the possible scenarios in process execution in order to avoid terminations. The algorithm of the process should handle different/new situations and to ensure stable working process for all cases.

Structured description of SQG process is divided into 7 steps and presented in Fig. 3, including the explanation of four SAP transactions, VA05, VA03, VA21, and YVAFE [20] involved in the process.

1/2 steps The first SAP transaction VA05 is used for getting, filtering and adding sales orders to the queue. The two steps are pretty simple: go to transaction, set company code and date period of sales orders, get all sales orders, add three more informational columns: material, description, order quantity. Filtering provides all sales orders by material numbers, but before this step it is necessary to read material numbers from *.xml* format file. The next step is to add all filtered sales orders to the queue. The sub-process "Populate Work Queue" uses only one SAP transaction to do its task. This sub-process cannot be performed by multi–robots because there will be created duplicates in a queue and the whole process cannot be separated in several independent parts.

3 step The "Main" sub-process needs the other three SAP transactions (VA03, VA21, YVAFE) to execute the process. The first transaction is used for getting information about the client (his/her e-mail and name). In this step there might be some business exceptions, because the robot may encounter missing values of an e-mail address or name. Here, the robot first of all goes to this transaction and writes a sales order document number. Next, it tries to go to the "Partners" tab to get an e-mail address. There is more than one tab and by default. Usually, the robot goes to the eighth tab, reads its name and if there is a "Partners" tab, the robot tries to get an e-mail address. If there is no such tab, it goes from the beginning of tabs one by one to find the "Partners" tab. When a robot finds an e-mail field, it reads it and saves into memory. If there is no email (after all searches) – it is considered as a business exception. The same actions are performed while searching for

the customer's name, but by default, robot is initially placed to the tenth "Order Data" tab.

4 step RPA service product analysis is performed in this step and it follows the actions, described in step 3.

5 step The second transaction VA21 is used to create a quotation. It is the most difficult transaction for a robot to perform. A digital worker has to write all data from VA05 and VA03 transactions very carefully and correctly. First of all, the robot goes to VA21 transaction, then sets up an initial screen, where all fields depend on the company and are always constant. Next, the digital worker has to fill in all the required fields to create a quotation. Required fields usually include - the purchase order number, document date, valid to date, some fields about company parameters and material numbers (must be read from *.xls* format file before writing). In this transaction, the robot has to enter the customer's name from the VA03 transaction, which is initiated after completing the required fields and the next actions are the same as in VA03 transaction with tabs. The essential thing is that a robot has to write the customer's name – not to read. If this action is performed correctly, SAP will display a message with information about the created quotation and its number. A robot has to filter out quotation number from the message using RegEx (regular expression) and save it to the memory.

6 step In this step RPA marketing material selection is performed. Here, the algorithm (see Fig. 1) for achieving part material is executed.

Data from Logic Template *.xls* format file is included in the *customer_MAT*. Meanwhile *A*, *B* or *C* is filtered one row from the corresponding lists. If sign "*X*" is found in *A* column, material number is recorded. Special case in *MAT* has two signs "*X*", therefore additional checking is performed to verify *part_MAT* value and the index. Additional checking is performed to identify if there is a *specific_Mat* in the order. If the returned value is true, *part_MAT* is added to *selected_MAT*. "*X*" sign denotes which *part_MAT* is selected (see Fig. 2).

7 step The last step is to go to the YVAFE transaction and send a quotation to the customer. The robot needs to go to the transaction, write quotation number, review quotation, write customer e-mail address, send quotation to the written e-mail address and close all confirmation pop-ups. These steps define the procedure, how the quotation is created and sent to a spe-

cific customer. The "Main" sub-process can be executed with multi robots. All robots can take data from different sales orders and create different quotations independently at the same time.

Pseudocode: RPA marketing material selection algorithm

```
Initialize customer_MAT two-dimensional list from excel file
Initialize order_MAT list from SAP sales orders
Initialize part_MAT list from excel file
Initialize selected_MAT list
while MAT > 0 in order_material
    List A = customer_MAT which contains MAT
    if ∃ special case in MAT then
        List B = specific_MAT value from order_MAT
        if List B ≠ ∅ then
            List C = customer_MAT ⊓ List B
            find "X" in List C and save index i
            write part_MAT value v with index i into selected_MAT
        else
            find first "X" in List A and save index i
            write part_MAT value v with index i into selected_MAT
    else
        find "X" in List A and save index i
        write part_MAT value with index i into selected_MAT
```

Figure 1: RPA marketing material selection algorithm

3. Realitazion

All interactions with SAP are executed using SAP scripting. SAP buttons, tabs, fields, windows, tables and other elements have their references. Using "Blue Prism" code stages and SAP references, robots can interact with elements in every possible way. For example, if there is a button, the robot can press it using the *code stage press* method. The biggest difficulties arise when there is a need to read the whole data table (all sales orders) into one data set called a collection. Collection in "Blue Prism" is like a two-dimensional array/ a hash table mix, like a two-dimensional array with a header. To use SAP scripting IDs of the session and connections must be known, but these IDs are always the same and usually are equal to zero. Connection ID always depends on how many users are connected to the same resource computer. The whole process should be done by one user and thus the connection ID should always be equal to zero. Session ID depends on how many SAP windows are open. It means that all transactions can be opened in different windows and have different session IDs. Using best practices, the robot always does its job in a transaction and goes to another transaction from the same window. As a result, the session ID always remains the same number and equal to zero.

The main goal of this process it time optimization.

◢	A	B	C	D	E	F	G
				Part Materials			
1				8044339	8044340	8044341	8044342
2	Material	Type	Name				
3	1501328	CMMP-AS-C10-11A-P3-M3	Motorcontroller	X			X
4	3215473	CMMP-AS-C15-11A-P3-M3	Motorcontroller	X			X
5	1622901	CMMP-AS-C2-3A-M0	Motorcontroller	X			
6	1501325	CMMP-AS-C2-3A-M3	Motorcontroller	X			X
7	1622903	CMMP-AS-C5-11A-P3-M0	Motorcontroller	X			
...	.....	.....					
15	572211	CMMS-ST-C8-7-G2	Motorcontroller	X			
16	3605478	CMXH-ST2-C5-7-DIOP	Controller		X		
17	2226101	EXCM-30-	Flächenportal		X		
18	3741955	EXCM-40-	Flächenportal		X		
19	1501331	CAMC-G-S3	Sicherheitsmodul				X

Special case because of two "X" in a line

Specific material due to special case

Figure 2: The example of a special case: having two material 1501328 and 1501331 only part material 8044342 is selected
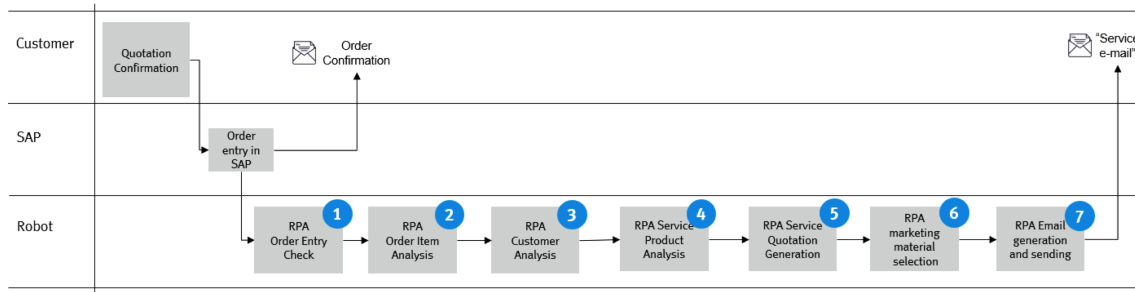

Figure 3: Scheme of automated service creation (original: agent quotation support)

The digital worker can generate one quotation much faster than physical human employee. Robots can work twenty-four hours per day, seven days a week without any pauses and breaks or holidays. Even one robot can increase the process of service quotation and reduce costs significantly. There is a need only for one physical human to ensure that digital worker operates properly.

3.1. Rules and Constrains

When the RPA process is executed, we cannot change any steps of the robot but we can do monitoring from the control room. There we can see the current robot step. Different applications such as "VNC Viewer" can be used to monitor real-time execution processes. "VNC Viewer" is a program for logging into another virtual environment allowing to view the processes from the outside. In case of an emergency, there is a possibility to untick "View only" checkbox from "VNC Viewer" parameters and make some changes in real-time pro-

cess execution. However, there is a possibility to immediately stop the process. In the control room we can request the stop for the current process and then the robot will stop process execution after it finishes a current case. There also are some certain variables, called "Session variables". Values of variables might be changed in the control room even when the process is in execution stage.

It is very important to denote general robot behavior rules and reaction to the information predefined in the settings file. However, such rules may be modified according to the required changing needs.

Rules according to the settings file:

1. Customer email must be found in a first choice line, if not – then in a second choice line, if not – then in a third choice line. If no email is found in all choice lines – business exception is recorded and the case is ended.

2. Quotation must be sent by email to primary responsible person and

3. to the customer, if there is a "yes" option selected (Question: "send a service quotation to the primary responsible person as well") in settings. If no email is found in the "Primary Responsible" line – business exception must be thrown.

4. Text from the settings must be added to PO (Purchase Order) number in quotation.

5. The date of PO must be selected from two options: (1) actual date or; (2) the date from the sales document.

6. The date must be validated by the value of the field " Valid to" calculated using formula:

$$Valid\_to\_date = PO_{date} + m \qquad (1)$$

where m denotes the number of months.

7. Customer cannot get another quotation if the inter-time t_{ij} between two consecutive quotations i and j (set in settings file) did not pass. In other words, the customer after one received quotation has to wait for a time period t_{ij} (for example 7 days). The time duration t_{ij} is predefined in the settings file.

8. Quotation cannot be created and sent to customer if the customer's number is included in a "Black list".

9. Quotation must be sent only to the primary email of the responsible person in case the customer's email is in a "Grey list".

Other Rules:

1. If the robot cannot send a quotation to the customer because of "SAP" limits, the sending operation must be repeated in a few hours or on the next day.

2. Sales orders with the same document number must be sent to the customers in one quotation.

3. Robot must find customer's name, if it cannot do that – a business exception must be thrown.

4. Robot must save all the data (customer's email, primary responsible person's email, quotation number and other data required for quotation generation) for report.

5. The Robot having order materials must find all part materials according to the algorithm described in Fig. 1.

4. Experiments

All the experiments have been carried out using the computer with the following main parameters: Windows 10 Enterprise, Intel(R) Xeon(R) CPU E5-2690 v4,
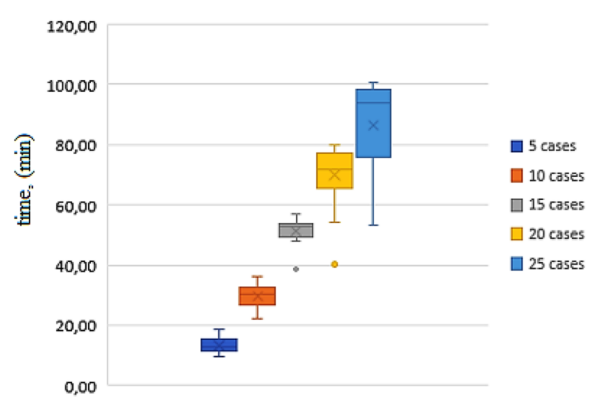

Figure 4: Processing time of cases (5, 10, 15, 20 and 25) performed by humans.
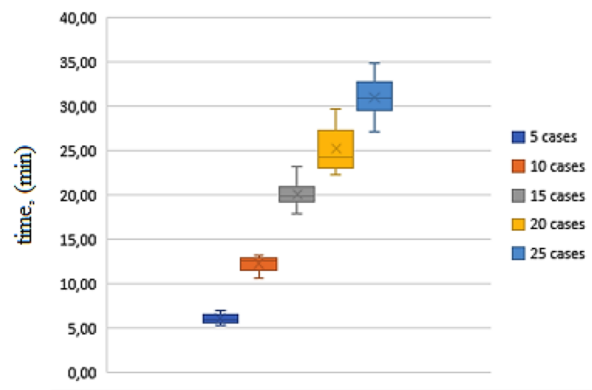

Figure 5: Processing time of cases (5, 10, 15, 20 and 25) performed by robots.

2 Cores, 3.20 GB RAM, 3.20 GB of total physical memory and 4.76 GB of virtual memory. SAP scripting, "Blue Prims" and Visual Basic frameworks has been used for creating realization models.

The evaluation of time efficiency of the implemented RPA experiments have been performed using different number of cases implemented into 5 scenarios. The same scenarios have been tested with humans - 20 participants have been involved in this research asking them to complete the tasks ensuring the same working conditions.

In Fig. 4 the diagram representing the time results achieved by humans performing different number of cases: 5, 10, 15, 20 and 25 is included. For completing 5 cases the average time required for human is 13.22 minutes, thus 2.64 for one case. With the increasing number of cases, the average time to complete one case is increasing as well and estimating the time to complete 25 cases, the average time to complete one case
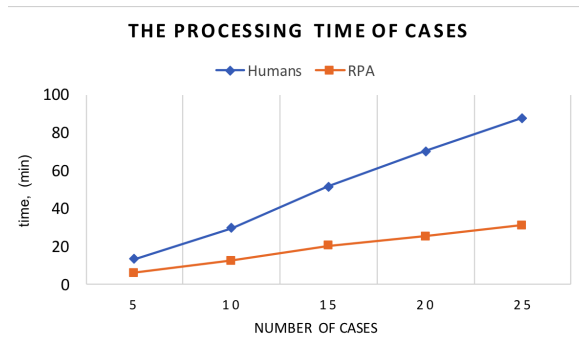
THE PROCESSING TIME OF CASES

Figure 6: Comparison or humans and robots time results achieved performing tasks.

is equal to 3.51 minutes. Meanwhile, estimating the average time to complete the same cases for the robot the constant value of $1.264 \pm 4.6\%$ to finish one case has been observed (Fig. 5).

Comparing the time results of humans and robot, we can see that superiority of the robot increasing with the increasing number of cases. With the small number of cases the robot can complete all cases twice faster than the human. The gap between results is more significant and reaches 2.82 times when the number of cases reaches 25 (Fig. 6). Performing the testing of the RPA process no logical loops or other critical errors have been observed. The whole process is fast, stable, ensures the task completeness and responds correctly to all input data.

5. Conclusions

This research paper has proposed an RPA approach for automated service quotation generation. The time-effectiveness of the proposed technology has been tested with different number of cases and compared with the results archived by humans. Comparing the time results of humans and robot, we can see that superiority of the robot is increasing with the increasing number of cases. With the small number of cases, the robot can complete all cases ~ 2 times faster than the human (taking the average time values calculated from all experiment participants). When the number of cases is equal to 25, the execution time of the robot is 2.82 times faster. Such results prove that the application of RPA is reasonable for the automated service quotation generation and could be valuable for different business companies, especially for those that have to complete a huge amount of operations every day.

In future work, we plan to improve the rules of our approach in order to ensure stable performance under unknown and conflicting situations.

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