# SERVICE QUALITY EVALUATION USING ROBOTIC PROCESS AUTOMATION TOOLS

Radu Florin NEGOIŢĂ[1], Theodor BORANGIU[2]

*Service quality is a vital component of the overall customer experience and should therefore be measured to know how the business' service measures up to the customer's expectations. The paper describes a Robotic Process Automation software tool for service quality control created for information-based service systems. The RPA bots are extended with artificial intelligence techniques used in the end-to-end automation of future service organizations. The software bots automate repetitive, time consuming human tasks (customer feedback evaluation, content analysis, data extraction) and speed up complex computations: OCR, data-driven analysis, support to intelligent decisions. Experiments performed with the Blue Prism tool are reported.*

**Keywords**: Service quality, customer perception, back-office robot, RPA.

## 1. Introduction

The activity model of a Service System (SSyst) is an approach derived from the service lifecycle. It indicates the interactions between the four stakeholders: service provider (including suppliers), customer, competitor and compliance bodies (government, legal national and EU service operating framework, authorities), and formalizes the service processes in view of their automation and information-based management [1]. Based on the analogy with Business Process Modelling (BPM), a business-oriented representation is created for the SSyst activities model to reach the service level agreement (SLA), set up and configure, deliver and monitor the service, analyse performance and assess quality with support from an information system [2], [3].

Service performance evaluation (SPE) and service quality (SQ) assessment are currently the main factors influencing operational efficiency and effectiveness and thus business performance of the service provider. In information-based service systems the SPE process uses consolidated data about the value (performance, cost) and perception (customer satisfaction and attitude, market opportunity, innovation perspective) of the requested or delivered service to negotiate the SLA respectively to improve the service. In this process, customer and provider co-create value [4].

[1] Ph.D. student, Doctoral School of Automatic Control and Computers University POLITEHNICA of Bucharest, Romania, e-mail: radu-florin.negoita@stud.acs.upb.ro

[2] Professor, Dept. of Automation and Industrial Informatics, University POLITEHNICA of Bucharest, Romania, e-mail: theodor.borangiu@upb.ro

A complete view of activity-oriented SSyst allows classifying SQ measures from five main perspectives: 1) content: establish standard operating procedures to be followed by the service staff; 2) process: maintain a logical sequence of activities and a well-coordinated usage of productive service capacity - equipment, facilities, work and infrastructure; 3) structure: adequacy of physical facilities and organizational design; 4) outcome: acceptable change in status effected by the service (the end result); 5) impact: long-range effect of the service on customers, also includes service accessibility [5].

Service quality is a vital component of the overall customer experience and should therefore be measured to know how the business' service measures up to the customer's expectations. Measuring SQ lets the service provider better understand the customers' needs and what they appraise from the business; it also helps to find deficiencies that can be solved to improve the customer's experience. SQ standards differ between service industries; yet a generally accepted and widely-used metric, based on a set of five dimensions that customers have regularly ranked as the most important for service quality in any industry, measures service quality [6], [7]:

- *Reliability*: the ability to perform the promised service both dependably and accurately - on time, always likewise and error-free.
- *Responsiveness*: the readiness to help customers and offer prompt service; it avoids keeping customers waiting and allows quick recovery from failure.
- *Assurance*: the knowledge and courtesy of employees and their ability to convey trust and confidence; it assumes competence to provide service, respect for the customer, politeness and real communication with the customer.
- *Empathy*: the provision of caring, individualized attention the firm provides to its customers.
- *Tangibility*: the appearance of physical facilities, equipment, personnel, and communication materials.

Customers use these five dimensions to form their judgements of SQ by comparing the expected service and the one perceived after delivery. The disparity between expected and perceived service can be used as a measure of the customer's satisfaction (and thus of SQ) that can be obtained in a feedback process organized by service firms. The customer feedback can be obtained in several ways: a) by asking customers to fill in *service quality questionnaires* immediately after an interaction, which guarantees that details are still relatively fresh in the customer's mind and hence more accurate; the service firm can thus take rapid corrective actions on the most urgent issues [8]; b) *in-app surveys* gather customer feedback directly; instead of sending a survey via email or paper format, in-app surveys pop up while the customer uses the mobile service application; c) *qualitative documentation analysis*: written and recorded customer service records (e.g., chat transcripts and call records) are analysed to get a deeper understanding of the service; d) *CES system*: a customer loyalty metric introduced in 2010 that measures how easy it is for customers to set up a service with the firm [9]; e) *Customer Satisfaction Score* (CSAT): a respondent expresses his short-term satisfaction for a service on a 5-point scale [10]; f) *Net Promoter Score* (NPS): focuses on long-term satisfaction and customer loyalty; NPS is considered to predict better customer behaviour and is strongly correlated with measures of company growth [11].

In the hospitality industry SQ questionnaires are used in principal to capture the customer's perception about the service expressed in the 5-dimension SQ space generally accepted. The SERVQUAL survey instrument is an operational tool for measuring customer satisfaction, based on the SQ gap model [12] which maps the potential disparity between expected and perceived service onto the five dimensions of service quality. Customer satisfaction is reached when the next four gaps related to service lifecycle stages are minimized: gap 1) *market research gap*: is caused by the firm's management faulty perception of customer expectations; gap 2) *design gap*: results from the management's incapacity to express SQ goals to meet customer expectations and to translate them into service delivery specifications; gap 3) *conformance gap*: happens when the service delivery does not meet the conditions set by firm's management; gap 4) *communication gap*: is caused by the difference between service delivery and external communication, e.g., exaggerated promises, and lack of information provided to front line employees. The SERVQUAL tool operates with 22 SQ attributes (expressed as questionnaire statements) distributed on the five SQ dimensions and collected in distinct formulations in two stages: the first one records customer expectations for the class of services of interest requested (e.g., hospitality), while in the second stage the customer perceptions of the services just delivered by a particular organisation (e.g., hotel) are gathered. A score for the service quality is computed as the differences between the ratings that customers assign to paired expectations and perception statements. The score is referred to as customer satisfaction, which results by aggregating the four types of inconsistencies identified in SQ gap model by the survey.

SERVPERF is another frequently used service quality metric [13] based on questionnaire that measures only performance perceptions from the same 22 quality attributes formulated in SERVQUAL. The SERVQUAL instrument assumes that customers express their scores by automatically comparing SQ perceptions with SQ expectations. Many service science researchers consider customers' expectations to be ambiguous; also, since expectation is considered as a type of attitude, customer expectations must be considered as ideal levels which rule out higher performance of service quality when perceptions progressively exceed expectations [14, 15, 16].

An organisation that manages its service system (SSyst) with informational support has the possibility to control service quality in a feedback control system which implies the correlation and synchronization of front-office and back-office processes - the first addressing customer feedback and digitalisation of perception questionnaires, and the second extracting perception data, computing the SQ score, identifying important issues and providing support to decisions for corrective actions. In the service sector, the Operations Management Software (OMS) automates routine tasks, manage strategic processes, control service quality and streamline operations to improve service delivery and increase customer satisfaction [17].

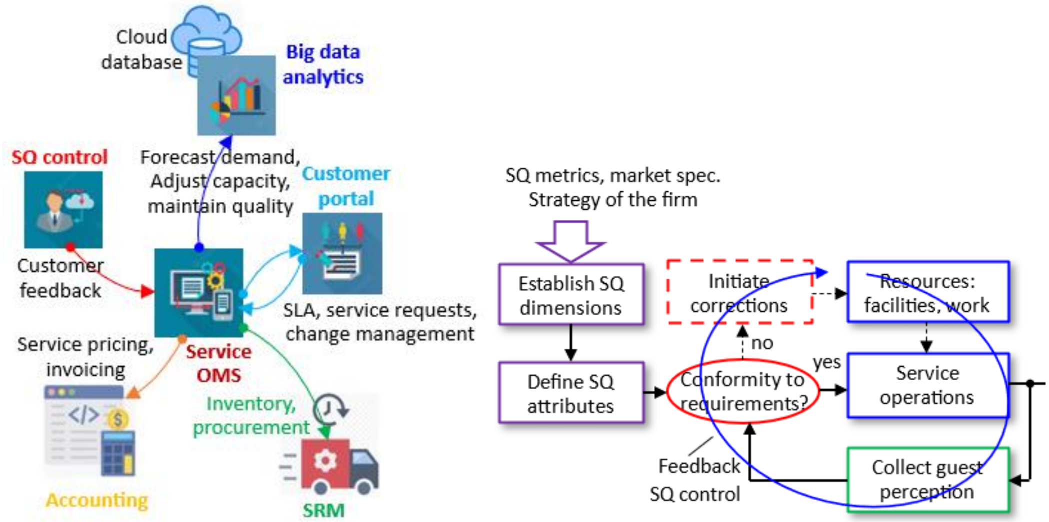
Intelligent Process Automation uses IT capabilities to automate OMS while interacting with user platforms, databases and computing infrastructure. Robotic Process Automation (RPA) represents actually a promising solution based on software robots (bots) to automate OMS tasks [18]. To integrate a service quality control in OMS, RPA must be extended beyond its rigid rule-based methods by equipping bots with artificial intelligence algorithms for optical character recognition, natural language processing and sentiment analysis in customer documents, and extracting insights on customer perception of SQ [19, 20].

The objective of the research reported in this paper is to develop an RPA-based solution for service quality evaluation and feedback control which uses the SERVPERF metric and importance-performance analysis (I-P) to identify those quality attributes of hospitality services that need to be remedied or enhanced or for which costs can be saved without quality decrease. SQ control with software robots automates front-office and back-office processes integrating them in the OMS of the hotel service system. Chapter 2 describes the structuring of the customer feedback questionnaire on the five quality dimensions and the prioritization of quality attributes through I-PA with possible market segmentation. Chapter 3 describes the software robots developed for RPA of SQ control. Experimental results are given in Chapter 4. The conclusions are formulated in Chapter 5 with emphasis on the perspective of intelligent RPA for end-to-end process automation.

## 2. Service quality control with customer feedback and I-P analysis

The proposed feedback control system for service quality is a component of the information-based SSyst, implemented with an operations management software for hospitality services. This OMS system is designed to influence and segment customer demand, adjust supporting facilities of limited hotel capacity and optimize work (staff level and assignment); these are back-office workflows that are kept consistent with the business strategy of the organization’s management and assist front-office activity workflows involving customers (service requests, service quality feedback) and front line personnel (service registration). The service OMS manages: a) *front-office processes*: customer reservations and registrations, guest service delivery, customer feedback; b) *back-office processes*: strategic planning, market segmentation, inventory, procurement, global accounting, quality control.

The integration of these OMS processes enables the end-to-end automation (E2E) of the activities referred by the SSyst model (see Fig. 1a).




a) OMS for front- and back-office processes b) SQ control integrated in the service OMS

Fig. 1. Integrating service quality control in the OMS for end-to-end automation of the SSyst

Fig. 1b depicts the service quality control which operates as a closed loop, feedback control scheme. The deviation from the service features defined by the firm's management and a priori accepted by the customers is seized through the weighted analysis of customer perception and generates appropriate corrections, e.g., upgrading hotel facilities, instructing front-line staff. The SQ control scheme operates as follows:

1. SQ set up: A set of objectives and measures of SSyst performance (types of service, delivery conditions, quality metrics) is established by the provider's management from to standard quality metrics, market segments of interest and adopted business strategy.
2. The customers' perception about SQ attributes is collected from questionnaires and analysed in the importance-perception SQ feature space.
3. The type of non-conformance to requirements (minor, major) is identified and a non-conformance report is generated as support to the decision to minimize or prevent it from occurring again: a) containment - keeping SQ within limits (e.g., alerting the client); b) immediate corrective action - plan the steps needed to bring back the service into conformance, assign responsibilities and time scales to tasks; c) root cause analysis - identify the reason for non-conformance and propose long-term solutions; d) validating effectiveness of the approach - implies rechecking the service [21].
4. Apply the corrective action(s) selected at step 3.

Monitoring service performance is impeded by the simultaneity of service delivery and consumption, which excludes direct interventions in the service process to observe non-conformance to assumed quality indicators. As a result, the feedback customer perception is collected through questionnaire after complete service delivery, which may be in certain cases too late to change the experience of the customer and keep him loyal.

The SERVPERF metric is used for customer feedback [13]. The survey questionnaire is structured on the five dimensions of service quality that are further detailed in groups of SQ attributes adapted for hospitality services, in total 22 items (Fig. 2).

*Table 1*

**Personalized questionnaire stating the customer's weighted perception of SQ attributes**

| **Customer #ID** | | | |
|---|---|---|---|
| **Customer data** | | | |
| **SQ dimension** | **SQ attribute** | **Set 1 (I)** | **Set 2 (P)** |
| **Tangibles** | Q1: The service firm has up-to-date equipment | | |
| | Q2: The physical facilities are visually appealing | | |
| | Q3: The employees are well dressed and appear neat | | |
| | Q4: The appearance of the physical facilities is in conformity with the type of services provided | | |
| **Reliability** | Q5: When the employees promise to do something at a certain time, they do so | | |
| | Q6: The employees are sympathetic and reassuring when customers have problems | | |
| | Q7: The employees are dependable | | |
| | Q8: The employees deliver the services timely | | |
| | Q9: The service employees keep their records accurately | | |
| **Responsiveness** | Q10: The employees tell customers exactly when services will be delivered | | |
| | Q11: It is realistic for customers to expect prompt services | | |
| | Q12: The employees are always willing to help customers | | |
| | Q13: The employees are never too busy to respond promptly to customers' requests | | |
| **Assurance** | Q14: The customers can trust the service staff | | |
| | Q15: The customers feel safe in their transactions with the service personnel | | |
| | Q16: The service employees are polite | | |
| | Q17: The employees get adequate support from the firm's management to do their jobs well | | |
| **Empathy** | Q18: The employees give customers adequate attention | | |
| | Q19: The employees give customers personal attention | | |
| | Q20: The employees know the needs of their customers | | |
| | Q21: The employees have their customers' best interests at heart | | |
| | Q22: The employees have operating hours convenient to all their customers | | |

The customers respond in the last two columns: Set 1 where they appreciate the importance I of the SQ attribute, and Set 2 where they rate their perception P on the performance of the SQ attributes. The scores for I and P are given on the 7-point Likert scale in the range of integers from 1 (strongly disagree) to 7 (strongly disagree).

Service quality (*SQ*) measured from the customer's satisfaction is evaluated by multiplying the scores declared in Set 2 for the perception on the performance of quality attributes $Q_i, 1 \leq i \leq 22$ with the weights assigned respectively to the scores of the importance $I_i$ of the items $Q_i$ in Set 1 of the survey questionnaire:

$$SQ_i = \frac{1}{k} \cdot \sum_{j=1}^{k} w_{ij} \cdot P_{ij} \quad (1)$$

where:

- $SQ_i$, $1 \leq i \leq 22$ is the quality component of the delivered service referred in item $Q_i$ of the SQ attribute list, evaluated by the feedback of $k$ customers (the mean value of the weighted perceptions collected from $k$ guests);
- $w_{ij}, 1 \leq j \leq k$ is the weighting coefficient of item $i$ (attribute $Q_i$ of service quality) acknowledged by customer $j$ in Set 1 (importance given to item $i$);
- $k$ is the number of responders of Set 1 and Set 2 in the survey questionnaire;
- $P_{ij}$ is the score of perception of customer *j* on the performance of the quality component $i$ ($Q_i$) for the delivered service, given in Set 2 of the survey.

The weighting coefficients $w_{ij}$ are the normalized scores given by customer $j$, $1 \leq j \leq k$ to the importance of the quality attribute $Q_i, 1 \leq i \leq 22$ formulated in the statement *i* of the feedback questionnaire:

$$w_{ij} = \frac{I_{ij} - m}{M - m} \quad (2)$$

where:

- $I_{ij}$, $1 \leq i \leq 22, 1 \leq j \leq k$ is the importance level set by customer *j* in Set 1 for the quality attribute $Q_i$;
- $m$ is the minimum value that can be granted to the importance score;
- $M$ is the maximum value that can be granted to the importance score.

In the quality evaluation process for the delivered service the values $m = 1$ and $M = 7$ are considered, i.e., the limit values of the 7-point Likert scale.

The weighted perception data about service quality performance, obtained from the customer feedback questionnaire, will further undergo the importance-performance analysis (I-P) in which the individual quality attributes $Q_i$ of the service are mapped in the weighted performance space $\boldsymbol{SP}_{IP} = \boldsymbol{I} \times \boldsymbol{P}$. In this 2D space, the coordinates of a point $Q_i$ are: h) the mean value of the perceptions of all respondents about the performance of the quality attribute $Q_i$ - along the horizontal axis, and v) the mean value of the importance scores given by all respondents to the selected quality attribute $Q_i$. Thus, the I-P analysis will prioritize the 22 quality attributes of hotel services function of the importance and perceived performance declared by the customers, grouped in the 5 quality dimensions related to hospitality services. The evaluation results are differentiated in the four 2D space quadrants: (NW): *Focus on a deficient quality component*; this SQ attribute and dimension to which it belongs become a priority for the firm's management, as they are judged of high importance; (NE): *Continue the service of good quality*; the actual delivery conditions should be maintained; (SW): *Low priority*: immediate corrective actions are not needed, possibly consider long-term changes; (SE): *Possible excess*: cost savings in service delivery could be eventually taken into account [22].

## 3. Design of the RPA bots that implement the service quality control

A Robotic Process Automation software has been developed for the service quality control scheme that involves both front-office processes (accessing the feed-back data) and back-office processes (validating the customer feedback, computing the guest satisfaction and analyzing the perception data). A number of software bots are aggregated for: 1) digitizing and storing the customer feedback surveys received during the last month; extracting and validating the scores I, P set by the responders; 2) performing the Cronbach $\alpha$ internal consistency test for the relatedness of quality attributes included in the SQ dimensions; 3) computing the perceived value of the service quality and the mean values of I, P for each right valued attribute; 4) identi-fying deficiencies and proposing operative measures.

The RPA bots are created using the Blue Prism software tool [23], in which the SQ control process is run on a predefined scheduler that automates the compu-ting workflows and data base handlings. The bots are trained to access standard feedback forms and tables of the OMS data base, and learn when to access the data, where to look for data, what is the data format, how to schedule sequences of SQL interrogations, and how to check the conformance of data. The RPA bots are also taught to compute the consistency of guest evaluations, to map results to 2D feature space, to analyse clusters of SQ performances and to detect outliers. The execution of the software bots aggregated in the RPA of SQ control is scheduled as follows:

1. Collecting and storing continuously individual guest feedback questionnaires with template shown in Table 1: a) on line forms are transferred by e-mail by customers and stored in the SQ control table of the OMS data base; b) physi-cal forms are collected by the staff at guest check-out, read by the OCR bot which converts them in digital format, and stored in the same table. *K* forms are initially stored in a month.
2. Extracting every end of month the data from the *K* digital forms received in the last month: i) #ID respondent; ii) respondent data: name, nationality, age, gender, civil state, profession, address, contact; iii) importance score $I_{i,j}, 1 \leq i \leq 22, 1 \leq j \leq K$ given by the customer with #ID = $j$ to the quality attribute $Q_i$

and read from column 3 (Set 1); iv) perception value $P_{ij}$ declared by guest #ID= $j$ for the performance of the quality component $Q_i$ and read from Set 2.

3. Analyzing the values given for the I, P scores in columns 3 and 4 of the feedback form. If in one form at least one value is missing in the fields Set 1 or Set 2 or has a value that is not an integer or is outside the [1 ... 7] Likert scale, the form is eliminated from the quality analysis. The #IDs of the remaining $k \leq K$ valid forms are re-numbered.
4. Performing the internal consistency test based on the Cronbach $\alpha$ coefficient which indicates the degree of relatedness of the set of quality attributes $Q_i$ included in the same SQ dimension. The test is successively executed for all 5 dimensions characterizing the quality of hospitality services: tangibles, reliability, responsiveness, assurance and empathy. Cronbach's alpha is used as confidence coefficient to validate the set of $Q_i$ reflecting the SQ dimensions, as the values measuring perception are supposed to satisfy the conditions [24]:
   - normal and linear distribution;
   - $\tau$ - equivalence: in the group population (on SQ dimension) all $Q_i$ items have the same type of relationship with the dimension's characteristic;
   - reciprocal independence of the perception collecting events.

   For $\alpha \in [0.7, 0.8)$ the internal consistency is considered as acceptable, respectively good for $\alpha \in [0.8, 0.9)$ and excellent for $\alpha \in [0.9, 1)$, while for values $\alpha < 0.7$ towards $\alpha < 0.5$ the consistency degrades respectively from questionable to unacceptable [25].

   To compute Cronbach alpha the RPA bot takes the score in Set 2 for each SQ attribute $Q_i$ and correlates them with the total score for each observation (respondent), making then the comparison with the variance for all the scores of the individual attributes. The $\alpha$ coefficient is computed by the bot as a func-tion of the number of attributes $Q_i, 1 \leq i \leq \dim_j (SQ)$, $1 \leq j \leq 5$ of dimen-sion $j$, of the mean covariance between pairs of perception scores for all attri-butes of dimension $j$ for all $k$ validated respondents, and of the global variance of the total measured score:

$$\alpha_j = \frac{j}{j-1} \cdot \left(1 - \frac{\sum_{k=1}^{n} \sum_{i=1}^{\dim_j(SQ)} \sigma_{i,k}^2}{\sigma_x^2}\right), 1 \leq j \leq 5 \tag{3}$$

   The mean covariance $\sigma_{i,j}^2, 1 \leq i, j \leq n, j > i$ between pairs of scores $(X, Y)$ of customer perceptions, that can take respectively the values $(x_i, y_i), 1 \leq i \leq k$ granted by the $k$ respondents, is calculated by the Cronbach RPA bot as:

$$\sigma_{i,j}^2 = \mathrm{cov}(X, Y) = \frac{1}{k^2} \sum_{i=1}^{k} \sum_{j>i}^{k} (x_i - x_j) \cdot (y_i - y_j) \tag{4}$$

   The global variance of all perception scores $P_{i,j}$ given to the SQ attributes of dimension $j$ by the $k$ respondents is ($\bar{P}_j$ is the mean value of all observations):

$$\sigma_{x,j}^2 = \frac{\sum_{i=1}^{n}(P_{i,j}-\bar{P}_j)^2}{n} \quad (5)$$

The Cronbach RPA bot emulates an Excel computation as indicated by Cucos in [26] (https://uedufy.com/how-to-calculate-cronbachs-alpha-in-excel/).

The software robot verifies the coefficients $\alpha$ computed for each domain. If for one domain $j$ the result is $\alpha < 0.7$, then this domain and all its quality attributes $Q_{i,j}, 1 \leq i \leq \dim_j (SQ)$ will be further eliminated from the analysis.

**5.** The computation RPA bot for I-P analysis calculates the following values:

- the weights $w_{i,j}, 1 \leq i \leq 22$ (or how many $Q_i$ remain after the verifica-tion made by the Cronbach RPA bot in step 4), $1 \leq j \leq k$ based on the importance scores $I_{i,j}$, as in eq. (2);
- the mean weights per quality attribute $Q_i$, $w_i = \frac{1}{k} \cdot \sum_{j=1}^{k} w_{i,j}$ and at survey level $wm = \frac{1}{22} \cdot \sum_{i=1}^{22} w_i$;
- the performance values $SQ_i$, $1 \leq i \leq 22$ (or how many SQ items remain after the test in step 4) of the quality attributes;
- the mean values $I_i = \frac{1}{k}\sum_{j=1}^{k} I_{i,j}$ and $P_i = \frac{1}{k}\sum_{j=1}^{k} P_{i,j}$, $1 \leq i \leq 22$ of the I, P coefficients at the level of quality attribute $Q_i$;
- the mean values of the I, P factors $Im = \frac{1}{22} \cdot \sum_{i=1}^{22} I_i$ and $Pm = \frac{1}{22} \cdot \sum_{i=1}^{22} P_i$ at survey level.

The RPA bot uploads the computed values in an I-P analysis table organized as in Table 2 for the RPA bot responsible for $(I_i, P_i)$ cluster analysis:

*Table 2*

**Mean values for SQ attributes provided by the computation bot to the I-P cluster analysis bot**

| **Domain** | $Q_i$ | $I_i$ | $w_i$ | $P_i$ | $SQ_i$ |
|---|---|---|---|---|---|
| Tangibles | $Q_1$ | | | | |
| ... | ... | | | | |
| Empathy | $Q_{22}$ | | | | |
| **Mean survey values** | | Im | wm | Pm | SQm |

**6.** The I-P cluster analysis bot makes the graphic representation of the mean scores $(I_i, P_i)$ for each quality attribute $Q_i$ included in the domain groups that meet the Cronbach $\alpha \geq 0.7$ internal consistency condition. The robot also performs the cluster analysis of $(I_i, P_i)$ - points in the weighted performance space: identifying their location relative to the four quadrants, detecting outliers, relating bad performances to the expectation-perception gap model, proposing corrections.

Fig. 2 shows the RPA diagram of the bot that automates the extraction of information from the digitalized customer feedback questionnaire.

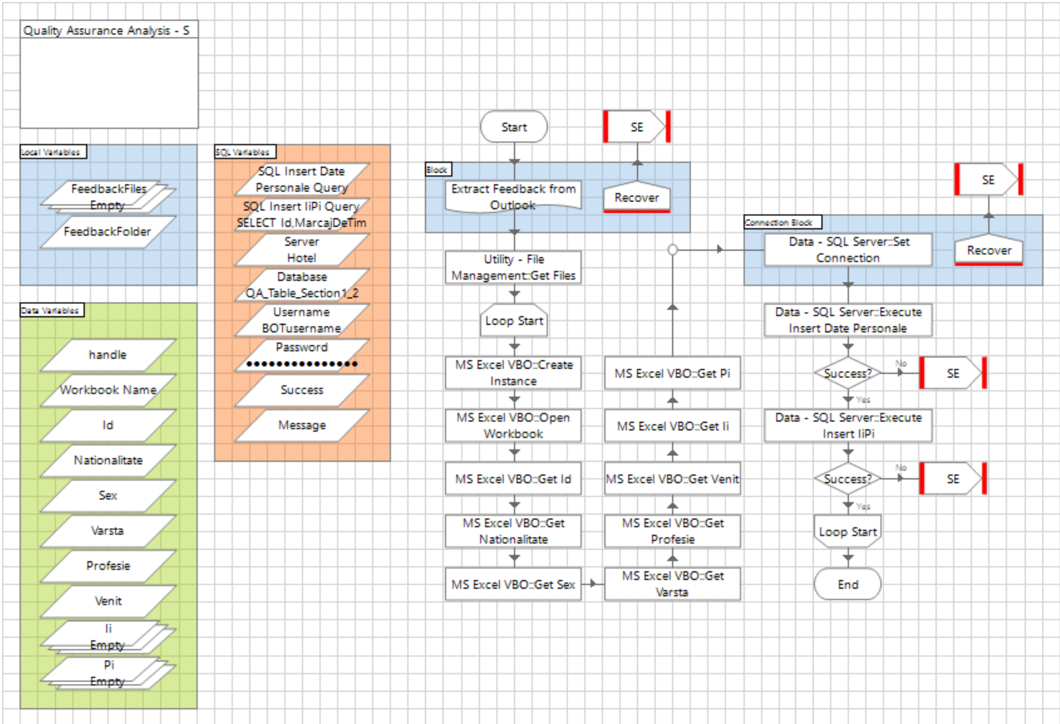



Fig. 2. RPA diagram of the bot that extracts guest data and I, P score values from the survey form

The bot fetches the e-mails received through the application Outlook and downloads their attachments - the customer surveys in the location “Extract Feedback from Outlook”; it gets them as *k* Excel files by help of the object “Utility - File Management::Get Files” and transfers them in an SQ table of the OMS data base. The guest #ID, I and P values are taken from this table by the bot in Fig. 3.

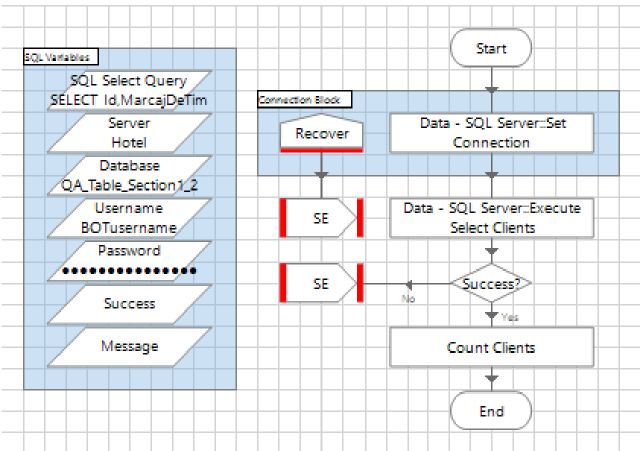



Fig. 3. RPA bot extracting guest #ID and (I, P) score values from the digital survey forms

The connexion with the data base (“Data – SQL Server:: Set Connection”) is realized setting as input parameters the names of the server and of the data base table, the username and authentication password. The, the bot does the interrogation **SELECT Id, I1,..., I22, P1,..., P22, FROM SERVPERF_Database** to extract the guest #ID and (I, P) score values for the $Q_i$ items. If the interrogation is successful, the bot checks whether the scores are inside the 7-point Likert scale. The computing and Cronbach bots include Python scripts for specific functions.

### 4. Experimental results

Experiments have been carried out to evaluate the performances of the software robots developed for the automation of service quality control with the Blue Prism v.7.1.1 Learning Community platform [27] and SQ data storage in a 64-bit SQL Server 2019 data base. The hardware requirements are: processor with min. 2 cores, 8G RAM, 100 GB storage. The RPA infrastructure was configured with 10 VMs mapped with bots for parallel upload and processing of feedback surveys.

The testing sample included 20 customer feedback questionnaires of the type shown in Table 1; the digital forms are structured on 22 attributes defined for hotel services in the SERVPERF metric, partitioned 4|5|4|4|5 in the 5 domains derived from the 5-stage guest satisfaction model evaluated on a 7-point Likert scale.

*Table 3*

**Results of the relatedness test (left) and SQ evaluation (right) from the 20 customers' feedback**

| Domains \| $Q_i$ partition | Cronbach alpha |
|---|---|
| Tangibles \| 4 | 0.768 |
| Reliability \| 5 | 0.832 |
| Responsiveness \| 4 | 0.871 |
| Assurance \| 4 | 0.878 |
| Empathy \|5 | 0.826 |

| Domain | $Q_i$ | $I_i$ | $w_i$ | $P_i$ | $SQ_i$ |
|---|---|---|---|---|---|
| Tangibles | Q1 | 6.05 | 0.84 | 6.05 | 5.12 |
| | Q2 | 6.10 | 0.80 | 6.05 | 4.92 |
| | Q3 | 6.05 | 0.79 | 5.75 | 4.62 |
| | Q4 | 6.05 | 0.84 | 5.85 | 5.01 |
| Reliability | Q5 | 5.95 | 0.75 | 5.50 | 4.27 |
| | Q6 | 6.00 | 0.78 | 5.40 | 4.28 |
| | Q7 | 6.00 | 0.83 | 5.35 | 4.76 |
| | Q8 | 5.95 | 0.76 | 5.40 | 4.20 |
| | Q9 | 5.65 | 0.77 | 5.70 | 4.44 |
| Responsiveness | Q10 | 5.90 | 0.77 | 4.95 | 3.84 |
| | Q11 | 5.85 | 0.75 | 5.35 | 4.06 |
| | Q12 | 5.85 | 0.74 | 5.15 | 3.95 |
| | Q13 | 6.00 | 0.76 | 5.20 | 4.66 |
| Assurance | Q14 | 5.75 | 0.79 | 5.55 | 4.40 |
| | Q15 | 5.45 | 0.74 | 5.25 | 3.86 |
| | Q16 | 5.50 | 0.75 | 5.35 | 4.02 |
| | Q17 | 5.20 | 0.70 | 5.85 | 4.13 |
| Empathy | Q18 | 5.55 | 0.75 | 5.85 | 4.23 |
| | Q19 | 5.35 | 0.82 | 5.70 | 4.75 |
| | Q20 | 5.45 | 0.80 | 5.65 | 4.57 |
| | Q21 | 6.00 | 0.83 | 5.55 | 4.61 |
| | Q22 | 5.60 | 0.82 | 5.65 | 4.67 |
| **Mean survey values** | | 5.78 | 0.78 | 5.55 | 4.43 |

The degree of relatedness for the attributes included in the domain partition has been verified with the Cronbach $\alpha$ RPA bot; the results show acceptable internal consistency for tangibles and good consistency for the other four groups (Table 3 left). The results of the I-P analysis are shown in Table 3 right. The quality attributes of highest importance are related to tangibles while the assurance attributes are the least important considered ones. The analysis of the perception scores reveals that hotel facilities, equipment and staff appearance are well appreciated (the tangibles' mean score is 5.92 exceeding the mean survey perception score), but responsiveness is only acceptable (mean perception 5.16) which indicates the necessity to better schedule service activities and assign them to front-line personnel.

These performance indicators calculated by the RPA metric computation bot are transposed in a graphic 2D representation of the weighted SQ attributes by the I-P cluster analysis bot, see the screen capture shown in Fig. 3.

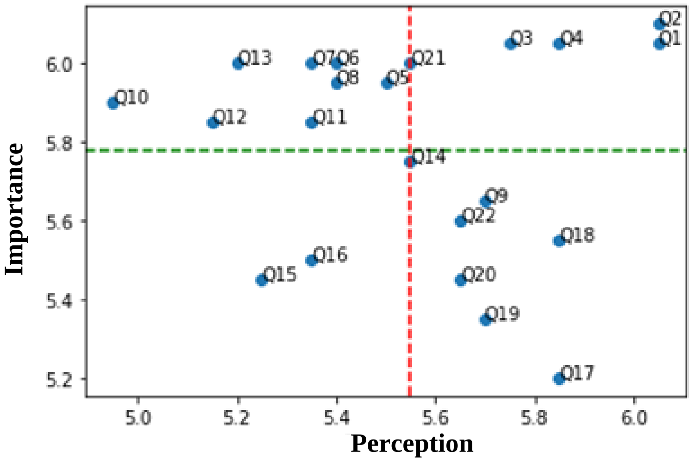



Fig. 3. Clusters of service quality attributes in the 4-quadrant I-P analysis

The graphic plot allows to cluster the SQ attributes in areas of conformance to requirements and quick adoption of corrective measures. Thus, the NW quadrant includes all responsiveness attributes, indicating major deficiencies that must be corrected immediately. The reliability attributes are also placed in the critic NW area, except for the outlier Q9 (records kept accurately) that is judged acceptable by the responders, although of lower priority. It also results that employees are well trained to perform their duties, although long-term changes should be considered to improve the interaction with sensitive guests. The mean score values at survey level partition the analysis space function of the customers' expectations (the position of the horizontal separator $\text{Im} = 5.78$, a high value indicating an exigent public) and the guests' perception (the position of the vertical separator $\text{Pm} = 5.55$, a high value indicating an infrastructure of high quality and professional staff).

The service quality analysis based on I-P clustering can be further detailed by customer segments: age, civil state, residence, etc.

## 5. Conclusions

Service quality control is an important factor for operational efficiency and effectiveness in the hospitality industry. In information-based service systems, quality control is a closed-loop process which uses consistent, consolidated data about the value (cost, performance) and perception (customer satisfaction and attitude, market opportunity, innovation perspective) of the requested and delivered service.

For a service business, controlling service quality infers the correlation and alignment in time of front-office processes (interaction with customers, digitizing and saving feedback forms, extracting perception data weighted by expectations) with back-office processes (checking the consistency of evaluations, applying SQ measurement metrics, identifying types of non-conformance with requirements, support to decision for corrections).

The paper describes a solution that automates service quality control processes in the framework of operations management software created for information-based service systems. The scientific contribution of the reported research consists in developing this solution in the hyperautomation vision, i.e., as a combination of robotic process automation (RPA) and artificial intelligence (AI) that will be used in the end-to-end automation of future organizations. The SQ control uses software RPA bots specialised in automating repetitive, time consuming human tasks (document management, content analysis, extraction of specific data), that are extended with AI techniques such as OCR, NLP, data-driven analysis and support to intelligent decisions to improve service quality and customer satisfaction [28].

The coordinated functioning of the intelligent bots has been orchestrated with the Blue Prism RPA scheduler to validate experimentally the developed solution. The experiments proved error-free computation, high-speed service quality evaluation (15 times faster with full robot automation than with human expert coordination), scalability and operating autonomy in dynamic context.

The results of the RPA software development can be applied for quality control in any service sector characterized by multiple interactions with customers; the proposed RPA-based SQ control can be configured by software to prioritize market segments (categories of customers), service quality elements (quality of service resources, performance of staff) or business objectives (e.g., in hospitality: stimulating the most profitable segments by granting them priority relative to limited capacity, increasing tenancy during off-season period, upgrading service delivery standards for shared capacity).

Future research is directed towards developing new intelligent RPA bots to automate front-office processes requiring continuous interaction of front-line staff with customers: registration, guest assistance during their stay, front office accounting and check out. These software robots will be integrated with back-office RPA bots that control strategic processes: overbooking, staffing optimization.

### Acknowledgements

The research presented in this article has been funded by the Ministry of Investments and European Projects through the Human Capital Sectoral Operational Program 2014-2020, Contract no. 62461 / 03.06.2022, SMIS code 153735.


## R E F E R E N C E S


[1]. *T. Borangiu, V.E. Oltean, M. Drăgoicea, J. Falcão e Cunha and I. Iacob*, Some Aspects Concerning a Generic Service Process Model Building, in Snene, M., Leonard, M. (eds) Exploring Services Science. IESS 2014. Lecture Notes in Business Information Processing, vol. **169**, pp. 1-16, 10.1007/978-3-319-04810-9_1, Springer, Cham, 2014.

[2]. *M. Weske*, Business Process Management. Concepts, Languages, Architectures, ISBN: 978-3-662-59431-5, doi: 0.1007/978-3-662-59432-2, Springer, Berlin, 2019.

[3]. *E. Bazhenova, F. Zerbato, B. Oliboni, M. Weske*, From BPMN process models to DMN decision models, Information Systems, vol. **83**, pp. 69-88, doi: 10.1016/j.is.2019.02.001, July 2019.

[4]. *S.L. Vargo and R.F. Lusch*, Institutions and Axioms: An Extension and Update of Service-Dominant Logic, Journal of the Academy of Marketing Science, vol. **44**, pp. 5-23, doi: 10.1007/s11747-015-0456-3, 2016.

[5]. *B. Klokkenga*, How to measure the 5 dimensions of service quality, GetFeedback article, https://www.getfeedback.com/resources/cx/how-to-measure-the-5-dimensions-of-service-quality/#:~:text=The%20five%20service%20quality%20dimensions,responsiveness%2C%20assurance%2C%20and%20empathy, November 2020, Accessed 10 January 2023.

[6]. *V.A. Zeithaml, A. Parasuraman, L.L. Berry*, Delivering Quality Service: Balancing Customer Perceptions and Expectations, Publisher: Simon and Schuster, ISBN: 9780029357019, 1990

[7]. *J.A. Fitzsimmons, M.J. Fitzsimmons*, Service Management: Operations, Strategy and Information Technology, $6^{th}$ edition, ISBN: 978-0073403359, McGraw-Hill, 2008.

[8]. *L. Souca*, SERVQUAL - Thirty years of research on service quality with implications for customer satisfaction, Int. Conference on Marketing from Information to Decision 4th ed., Cluj-Napoca, Marketing - from Information to Decision, pp. 420–429, ISSN 2067-0338, 2011.

[9]. *M. Dixon, K. Freeman, N. Toman*, Customer Experience: Stop Trying to Delight Your Customers, Harvard Business Review, https://hbr.org/2010/07/stop-trying-to-delight-your-customers, July-August 2020.

[10]. *M. Khandelwal*, CSAT vs NPS vs CES: When to use which survey?, surveySENSUM, https://www.surveysensum.com/blog/csat-vs-nps-vs-ces/, 2022.

[11]. *M. Pandey*, What Is Net Promoter Score (NPS)? - A Guide, Marketing & Sales Guides, FEEDOUGH, https://www.feedough.com/net-promoter-score/, 2023

[12]. *A. Parasuraman, V. Ziethaml, L. Berry*, SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality, Journal of Retailing, vol. **62**, no. 1, pp. 25-36, 1988.

[13]. *J. J. Cronin, Jr., S.A. Taylor*, Measuring Service Quality: A Reexamination and Extension, Journal of Marketing, vol. **56**, no. 3, pp. 55-68, doi: 10.2307/1252296, July 1992.

[14]. *L.L.R. Rodrigues, G. Barkur, K.V.M. Varambally, F. Golrooy Motlagh*, Comparison of SERVQUAL and SERVPERF metrics: an empirical study, The TQM Journal, vol. **23**, no. 6, pp. 629-643, doi: 10.1108/17542731111175248, Emerald Group, 2011.

[15]. *O. Moisescu, O.A. Gică*, SERVQUAL versus SERVPERF: Modeling Customer Satisfaction and Loyalty as a Function of Service Quality in Travel Agencies, Studia Universitatis Babeş-Bolyai, Oeconomica **58**(3):3-19, January 2013.
[16]. *A. Czajkowska, M. Ingaldi*, Application of Servqual and Servperf Methods to Assess the Quality of Teaching Services - Comparative Analysis, Manufacturing Technology, vol. **21**, no. 3, pp. 294-305, doi: 10.21062/mft.2021.041, ISSN: 1213–2489, June 2021.
[17]. *SciSoft*, Operations Management Software 360-Degree Overview, ScienceSoft 2023, https://www.scnsoft.com/operations-management#service-oms, accessed on 23 Feb 2023.
[18]. *S. Kumar*, Robotic Process Automation, Int. Research J. of Modernization in Engineering Technol. and Science, vol. **2**, issue 7, pp. 1248-1251, 2020.
[19]. *Gartner*, Top Strategic Technology Trends for 2022: Hyperautomation, Document 00756559, https://www.gartner.com/en/newsroom/press-releases/2021-10-18-gartner-identifies-the-top-strategic-technology-trends-for-2022, Gartner, October 2021.
[20]. *H.P. Fung*, Criteria, Use Cases and Effects of Information Technology Process Automation (ITPA). Advances in Robotics & Automation **3**: 124, doi: 10.4172/2168-9695.1000124, 2014
[21]. *G. Frolovs*, What Is Non-Conformance And How to Minimize It, Simpler QMS, August 2021, https://www.simplerqms.com/non-conformance/
[22]. *D.R. Rasyida, M. Mujiya Ulkhaq, P.R. Setiowati, N.A. Setyorini*, Assessing Service Quality: A Combination of SERVPERF and Importance-Performance Analysis, MATEC Web of Conferences 06003 (2016), ICIEA, doi: 10.1051/matecconf/20166, 2016.
[23]. *Blue Prism*, The Modern CSP is a Technology Company - and Intelligent Automation is a Differentiator, Whitepaper, https://www.blueprism.com/resources/white-papers/intelligent-automation-in-the-modern-csp/, published by Mobile World Live, 2022.
[24]. *E. Cho*, A Comprehensive Review of So-called Cronbach's Alpha, KOAJ Korea Open Access Journals, vol. **38**, Issue 1, pp. 9–20, doi: 10.36345/kacst.2020.38.1.002, 2020.
[25]. *T.J. Dunn, T. Baguley, V. Brunsden*, From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation, British Journal of Psychology, vol. **105**, Issue 3, pp. 399–412, doi:10.1111/bjop.12046, 2014.
[26]. *L. Cucos*, How To Calculate Cronbach's Alpha in Excel, UEDUFY, https://uedufy.com/how-to-calculate-cronbachs-alpha-in-excel/, 8 Feb. 2023, accessed on 12 March 2023.
[27]. *SS&C blueprism*, Blue Prism 7.1.1: September 2022, https://bpdocs.blueprism.com/bp-7-1/en-us/release-notes/rn-7-1-1.htm, accessed 16 December 2022.
[28]. *S. Kemsley*, Hype or Hyperautomation? End-to-End Automation. Whitepaper, Flowable, https://www.flowable.com/hyperautomation-whitepaper, 2022.