How to Measure RPA's Benefits? A Review on Metrics, Indicators, and Evaluation Methods of RPA Benefit Assessment

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Abstract. RPA is a new approach to automating processes that has gained momentum in recent years. Research and vendors highlight potential benefits of RPA, such as increased efficiency, quality, cost reduction, and higher customer and employee satisfaction. However, as interest in RPA grows, so does the need to demonstrate its benefits, which in turn requires a suitable toolbox of metrics, indicators, and evaluation methods. To the best of our knowledge, an overview of RPA benefit assessment possibilities is lacking. In this paper, we identify 62 distinct metrics/indicators and ten evaluation methods used for assessing RPA benefits. Our results show that efficiency- and cost-related performance indicators prevail in the scientific literature. In terms of evaluation methods, most contributions do not mention any specific method for RPA benefit assessment. Our findings serve practitioners and researchers with an overview of the current possibilities for a realistic RPA benefit assessment and a corresponding research agenda.

Keywords: Robotic Process Automation, RPA, benefits, assessment, metrics

1 Introduction

Robotic Process Automation (RPA) is a novel approach to automating processes, which has grown in importance in recent years [1]. By using software robots that easily interact with the user interface in a human-like manner, RPA is regarded as an efficient method for the automation of tasks (e.g., extracting data, filling in forms, logging into systems) [2].

As vendors and the literature repeatedly promise, RPA is said to offer several benefits, such as higher efficiency rates, improved quality and compliance, and increased customer and employee satisfaction, to name just a few [1, 3]. Based on those expectations, RPA has become widely adopted in businesses and industries with growing market revenue [4]. However, many of these promises lack traceable assessment or evaluation. RPA benefits are often cited from one author to another without providing further credentials [1] and the feasibility of RPA bot implementation is usually based on generic rules of thumb. Companies even risk misinvestments due to

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misconceptions about the real potential of RPA in terms of automating their processes. Consequently, it is crucial to get a picture of RPA-specific benefits and associated metrics, indicators, and evaluation methods, as, e.g., Vitharanage et al. also state in their paper [3]. To the best of our knowledge, such a picture has been lacking so far.

To address this issue, our paper aims to extract metrics, indicators, and evaluation methods that are specifically used or proposed to assess the promoted RPA benefits. In consequence, we pose the following five research questions (RQ) in this paper:

- **RQ1:** What specific metrics and indicators are already proposed or used in the existing literature for assessing the benefits of RPA?
- **RQ2:** What metrics and indicators for assessing the benefits of RPA dominate the research?
- **RQ3:** What specific evaluation methods are already proposed or used in the existing literature for assessing the benefits of RPA?
- **RQ4:** What evaluation methods for assessing the benefits of RPA dominate the research?
- **RQ5:** What research desiderata are discussed in the existing literature regarding metrics, indicators, and evaluation methods for assessing the benefits of RPA?

To answer these questions, we follow vom Brocke et al.'s rigorous approach to conducting literature reviews (LR) [5]. Our findings are intended to provide practitioners and researchers alike with an overview of the current possibilities for a realistic RPA benefit assessment. In addition, we provide a research agenda that researchers can use as a starting point for further research on the subject matter.

The remainder of this paper is structured as follows. In Section 2, we introduce the theoretical background of RPA technology and its benefits. In Section 3, we describe our research methodology. Our findings on RPA metrics, indicators, and evaluation methods are presented in Section 4, answering the above-stated RQ1–RQ4. In Section 5, we present the results of our literature analysis of research desiderata to address RQ5, before we finally conclude the paper in Section 6 with a summary of the main findings and a discussion of central limitations.

2 Theoretical Background on RPA and Conceptualization of Benefit Dimensions

RPA is an approach to automating processes using software robots – so-called softbots – that mimic human interactions to execute mostly predefined and rule-based tasks in an automated manner [6–10]. Therefore, these bots are often referred to as digital workforces or virtual employees [11–13]. In contrast to other automation approaches, RPA uses the presentation layer and interacts with the graphical user interface to execute processes. Thus, neither intensive API programming nor changes to the existing application and legacy systems are necessary [2, 10, 14]. RPA is, therefore, often denoted as lightweight IT [15].

Since our goal is to approach the assessment of RPA from a benefit-driven perspective, in this section of our paper we focus on the discussion of different benefit attributes that are ascribed to RPA, which we subsequently cluster into dimensions. In line with vom Brocke et al [5], we then use the different benefit dimensions to conceptualize the topic. To this end, vom Brocke et al. [5] recommend the procedure suggested by Baker [16], who state that "to begin with one should consult those sources most likely to contain a summary or overview of the key issues relevant to a subject."

RPA's main benefits are said to include efficiency potentials due to higher transaction volumes, shorter throughput times, and fewer delays [11, 17–22]. This also improves availability, since RPA bots offer additional capacities in a 24/7 manner and are not prone to illness, business hours or vacations [8, 11, 17, 23–26]. Cost benefits are usually attributed to higher Returns on Investment (ROIs) and shorter payback periods, as well as the reduction of quality, compliance and FTE-related costs (FTE meaning Full Time Equivalent) like reduced headcount or payments for overtime [9, 11, 13, 24, 25, 27–35]. Quality and compliance improvements are reportedly achieved through better transparency and documentation (e.g., consistent log data), the promotion of process standardisation, as well as the adherence to predefined rules [8, 9, 11, 17, 18, 22, 29, 30, 36, 37]. Therefore, errors and rule-/process-deviations are said to be reduced leading to a higher accuracy and reduced fraud during process execution [8, 10, 11, 17–19, 30, 32, 36–38]**.**

RPA also improves scalability and flexibility [6, 8, 31, 39, 40]. The easy configuration as well as the modularity and reusability of RPA components appears to allow an easy adjustment of softbots, which enables quick reactions to changing conditions. RPA bots are therefore easily and rapidly modifiable and thus scalable to increasing process volumes, unlike traditional software adaptations that usually require advanced programming skills and major changes [11, 15, 17, 18, 25]. The literature has also mentioned a high interoperability with other application systems as well as lower implementation efforts. The drag-and-drop fashion of most RPA tools, the reusability of their components, and the low programming effort required simplify RPA configuration [1, 10, 15, 19, 25, 29, 31, 41]. Furthermore, no complicated system integration (no APIs or advanced programming) is said to be required, especially with regard to customized or legacy systems [2, 9–13, 15, 17, 19, 24, 25, 29, 33–35, 40, 42–44]. Therefore, compared to heavyweight IT solutions (e.g., BPMS or enterprise software), less time and effort have to be invested to implement RPA while allowing faster development of further RPA robots [8, 15, 29, 31]**.** Lastly, RPA promises both higher employee/customer satisfaction and higher service quality, as employees are steadily relieved from mundane tasks and can turn to more creative and value-adding activities [11, 17, 18, 20, 24, 25, 28–30, 32, 37, 45–47].

An overview of the benefits of RPA and its corresponding attributes is depicted in Figure 1. For the purpose of conceptualization and for further analysis, we assigned the benefit attributes to a total of nine dimensions. Efficiency (EF) refers to an optimal input-output ratio (minimum input at constant output or maximum output at constant input) [48] and thus subsumes transaction volume, throughput time, and delays, whereas availability (AV) focuses on all-time executability of bots and their services regardless of business hours, illnesses, etc. Scalability and Flexibility (SF) denote an adaptable variation in size and resources [49] and, therefore, the easy adjusment of bot numbers and configuration.

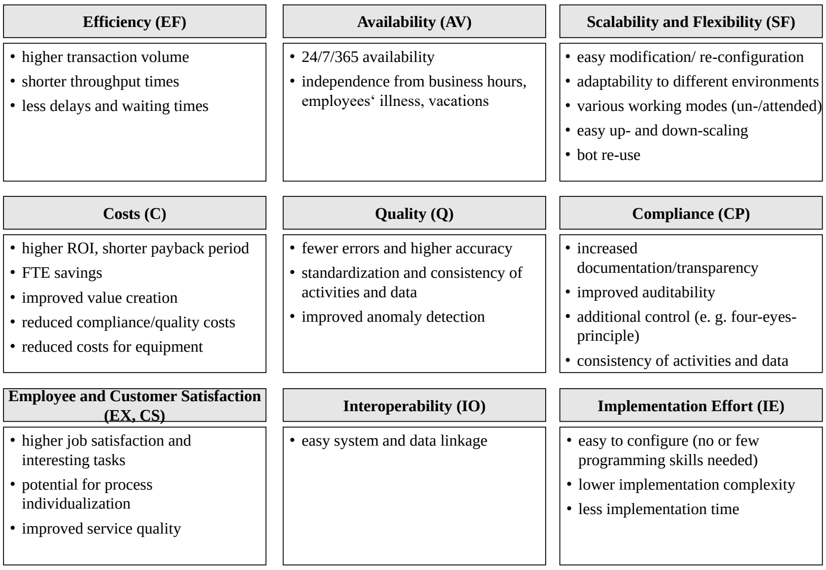

Figure 1. RPA benefit dimensions and attributes

The cost (C) dimension describes the level of financial effort for the provided services [50] and clusters all RPA effects that are related to a financial perspective (e.g., FTE savings, higher ROI). Quality (Q) generally means the level to which certain requirements are met [51] and subsumes error- and accuracy-related effects, in comparison to compliance (CP), which focuses more closely on the adherence to requirements resulting from laws, regulations, standards, and norms within and outside an organization [52]. As such, the latter summarizes increased controls, consistency of activities, etc. The definition of Employee and Customer Satisfaction (EX, CS) is based on user experience and satisfaction, thus considering employees and customers as a special set of users whose individual experiences, requirements, and wishes are to be addressed [53]. Interoperability (IO) is defined as the interaction of different systems, agents, and technologies. Implementation Effort (IE), as its name implies, is the effort in resources (e.g., time) needed to implement the RPA bot. Therefore, we subsumed the level of complexity, time required, and skills needed for bot configuration under IE. Based on the theoretical background and conceptualization of RPA benefit dimensions, we conducted a LR, whose procedure is described in the following section.

3 Research Method

Vom Brocke et al. [5] propose five major steps to follow in an LR: 1) definition of a review scope, 2) conceptualization of the topic, 3) literature search, 4) literature analysis, and 5) establishing a research agenda.

To define our research scope, we followed Cooper's proposed taxonomy, which includes six characteristics 1) focus, 2) goal, 3) audience, 4) coverage, 5) organization, and 6) perspective [54]. The LR emphasis is on research outcomes, methods, and applications (1), the synthesis and integration (2) of which is intended to address practitioners as well as general and interdisciplinary scholars (3) from the domain of RPA. Since we focus on metrics, indicators, and evaluation methods for RPA benefit assessment, we narrowed down the topic and research sources accordingly but still did an extensive search within the defined range. Thus, our research was both selective and exhaustive in nature (4). The identified results were organized as concept-centric (metrics/indicators) and author-centric (evaluation methods) by means of different concept matrices (5). Lastly, the results are presented in a neutral way (6).

In the second step, we conceptualized the topic area using RPA benefit dimensions, as described above in Section 2.

We started the third step with an initial search on Google Scholar, by scanning fundamental literature on the topic of RPA (e.g., [8, 9, 18, 33, 38]) to uncover relevant search terms. As initial searches indicated, RPA also serves as the abbreviation for replication protein A in the context of DNA research. Therefore, the acronym RPA was excluded from the research string to reduce the number of irrelevant articles. The final search strings are presented in Figure 2.

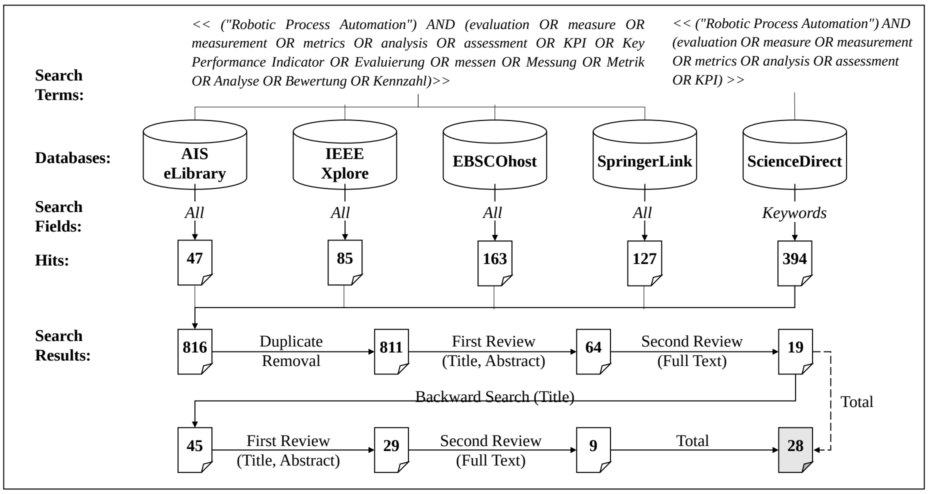

Figure 2. Literature search process

Based on these outcomes, we started our LR and used the strings to search the following well-known databases from May to June 2021: AISeLibrary, IEEEexplore, Science Direct, EBSCOhost and SpringerLink. These databases provide access to such leading IS journals as MIS Quarterly and the Journal of Information Technology. The used search fields in each database are presented in Figure 2. In total, we received 816 hits, among which we identified five duplicates.

To ensure that only relevant papers were considered, we defined six exclusion criteria (EC) in line with our research questions and excluded contributions that were of an introductory nature and did not directly contribute to the subject matter (e.g., editorials, call for papers, market research papers, or individually listed book chapters like contents, conclusions, index, glossaries) (EC1); were not available in English or German (EC2); did not explicitly deal with the assessment of RPA technology (e.g., papers in which RPA is only presented in very general terms or RPA is just mentioned in passing) (EC3); had a different understanding of the concept of RPA and its distinction from other forms of automation (e.g., authors who denoted classical programming, including API, etc. as RPA or who considered RPA and Cognitive/Artificial Intelligence as interchangeable concepts) (EC4); were not available online (e.g., broken links) (EC5); and were non-citable (e.g., bachelor's or master's theses) (EC6).

With these criteria in mind, the available literature was selected based on their titles and abstracts. The remaining 64 articles were then read in full and again reviewed with respect to EC1 to EC6, resulting in 19 papers. Subsequently, these 19 articles were used for a title-based backward search, resulting in the addition of 45 articles. These 45 additional articles were subjected to the same two review phases considering EC1 to EC6. The search process finally resulted in 28 papers that were considered relevant to address our research questions.

4 Analysis and Synthesis of RPA Literature

To answer our above-stated research questions and to integrate our findings according to step 4 of the LR procedure, we used both the concept-centric (RQ1/RQ2) and the author-centric approach (RQ3/RQ4) of Webster and Watson [55]. The concept matrix in Table 1 addresses RQ1 and RQ2 by listing the metrics and indicators for RPA benefit assessment (rows), which are mentioned by the respective authors (columns). The metrics and indicators are further clustered according to the RPA benefit dimensions presented in Section 2.

As for RQ1, a total of 62 unique metrics and indicators were extracted from the relevant literature, which appear to be useful concerning RPA benefit assessment. Various metrics and indicators are suitable for the assessment of multiple benefits and are therefore assigned to several dimensions, as can be seen in Table 1. In this regard, the dimensions Quality and Compliance, for example, overlap and mostly share the same metrics or indicators (e.g., accuracy, the number of unsuccessful terminations, or rework loops). Other metrics are subsumed under the same term but are calculated differently by various authors (e.g., stability, the calculation of labor costs, the level of standardization). A large number of indicators is presented by [56] (33), [57] (29) and [42] (16). Whereas some authors already provided detailed metrics (e.g., [42, 56]), others remained rather vague in their explanations (e.g., [11, 58]). Furthermore, some key figures, such as the number of agents, are used for the calculation of aggregated metrics like transaction volume or availability rate. In general, most of the metrics and indicators presented are theoretical in nature and require further validation and an appraisal of their suitability. Moreover, some metrics could be difficult to follow (e.g., the Cost-performance Ratio (CPR) according to [36]) and should be tested for practical applicability.

Table 1. Concept matrix: Metrics and indicators to assess RPA benefits

	[60]	[67]	[70]	[18]	[28]	[09]	[17]	[11]	[24]	[25]	[06]	[68]	[65]	[61]	[10]	[62]	[36]	[56]	[42]	[63]	[19]	[59]	[69]	[20]	[64]	[58]	[66]	[57]	Total
Efficiency (EF)																													**51**
average process or activity execution time (per agent)	x					x	x	x	x	x	x	x	x	x	x	x		x	x		x	x		x			x	x	19
total number of transactions and processed cases (per period)											x				x							x		x					4
average number of agents (active/non-active, per unit, per period)			x	x	x	x									x			x						x			x	x	9
number of transactions (per period and agent)			x	x	x	x				x	x	x		x	x	x		x	x					x				x	14
average number of different activities per day											x																		1
time spent on repetitive tasks								x																					1
time to solve manual interaction/handling time																		x		x									2
service and waiting times as idle time of a case																						x							1
Availability (AV)																													**6**
availability rate in % / bot downtime							x															x						x	3
reduced number of workload peaks								x																					1
number of licences																												x	1
licence usage																												x	1
Scalability and Flexibility (SF)																													**25**
automation rate		x	x	x	x	x					x							x	x								x	x	10
number of bots per 1000 employees																											x		1
robotic scale as number of humans orchestrating total of bots					x																								1
average number of agents (active/non-active, per unit, per period)			x	x	x	x									x			x						x			x	x	9
number of users performing same task																		x											1
variance of an activity's execution time																			x										1
number of licences																												x	1
licence usage																												x	1
Costs (C)																													**48**
total of labor hours saved (per period)		x	x																										2
ROI (1-year, 3-year) / breakeven for investments / payback period		x	x		x	x						x		x															6
FTE savings / reduced or redeployed headcount		x	x	x	x	x		x					x	x		x									x		x	x	12
IT expenses (licenses, servers, hostings, prebuilt bots)												x																x	2
labor-related costs (implementation, development, monitoring)												x																	1
fixed cost of human labor per process (execution independent costs)																			x										1
variable cost of human labor (execution dependent costs)																			x										1
fixed cost of RPA as cost rate for bot configuration, maintainance etc.																			x								x		2
variable cost of RPA based on service vendor(s) agreement(s)																			x								x	x	3
one-time costs (consultants, licenses, hardware, development, training)																												x	1
running costs (hardware, server operation, licenses, virtual clients)																												x	1
total of compliance costs related to audit, compliance requirements etc.																										x			1
Cost-Performance Ratio (CPR)																	x												1
number of users involved in process																		x											1
automation rate		x	x	x	x	x					x							x	x								x	x	10
time to solve manual interaction/handling time																		x		x									2
savings from continuous improvement projects attributed to RPA																										x			1
Quality (Q)																													**25**
accuracy as success rate/error rate/rate of deviation cases		x						x				x	x	x		x		x		x	x	x					x	x	12
increase of standardization in % /number of activity or process variations								x										x	x										3
number of unsuccessful terminations																		x											1
number of rework loops/corrective activities/redundant activities																		x	x										2
stability as number of exceptions/cases deviating from common process																		x											1
variance of an activity's execution time																			x										1
percentage of corrected and accepted errors regarding total error number																												x	1
availability rate in % / bot downtime							x															x						x	3
successful User Acceptance Tests (UATs)																												x	1
Compliance (CP)																													**26**
increase of standardization in % /number of activity or process variations								x										x	x										3
increase in automated controls in %																x													1
accuracy as success rate/error rate/rate of deviation cases		x						x				x	x	x		x		x		x	x	x					x	x	12
number of unsuccessful terminations																		x											1
number of rework loops/corrective activities/redundant activities																		x	x										2
stability as number of exceptions/cases deviating from common process																		x											1
variance of an activity's execution time																			x										1
percentage of corrected and accepted errors regarding total error number																												x	1
rate of false positives concerning risk identification																				x									1
risk factor reduction																										x			1
percentage of cases with compliance issues																						x							1
total of compliance costs related to audit, compliance requirements etc.																										x			1

	[60]	[67]	[70]	[18]	[28]	[09]	[17]	[11]	[24]	[25]	[06]	[68]	[65]	[61]	[10]	[62]	[36]	[56]	[42]	[63]	[19]	[59]	[69]	[20]	[64]	[58]	[66]	[57]	Total
Interoperability (IO)																													**4**
time spent on application interface																		x											1
number and types of involved systems and applications																		x										x	2
complexity score and range (number of screen views and applications)																									x				1
Implementation Effort (IE)																													**16**
development and rollout time														x			x											x	3
number of users performing same task																		x											1
stability as number of exceptions/cases deviating from common process																		x											1
number of execution steps																		x											1
number and types of involved systems and applications																		x										x	2
increase of standardization in % /number of activity or process variations								x										x	x										3
variance of an activity’s execution time																			x										1
complexity score and range (number of screen views and applications)																									x				1
number of change-requests per bot																												x	1
change-request duration per bot																												x	1
successful User Acceptance Tests (UATs)																												x	1
Employee and Customer Satisfaction (EX, CS)																													**14**
reduction of customer chase-up calls in % per year			x			x																							2
backlog of late activities					x																								1
number of complaints cleared within 24-hours / time to solve exceptions					x													x											2
complaint rate/complaints per period					x																								1
notification rate on service status					x																								1
Customer Satisfaction Score (CSAT)												x																	1
Net Promoter Score (NPS) as recommendation index												x																	1
improvement rates												x																	1
absenteeism												x																	1
employee turnover rate (terminations triggered by employees)																											x		1
urgency as average reaction time on complaints																		x											1
User acceptance as perceived usefulness and perceived ease of use																							x						1

Table 1 provides an additional overview of the absolute frequency of occurrence, the degree of coverage of the individual RPA benefit dimensions, and the metrics/indicators assigned to them. To answer RQ2, row sums were calculated. Based on this, the metrics and indicators that dominate research can be determined, such as the average process or activity execution time (per agent) mentioned in 19 out of 28 of the publications (68%) or the number of transactions (per period and agent) mentioned in 14 out of 28 of the publications (50%). All other row sums are to be interpreted analogously.

In addition, we accumulated the row sums for all RPA benefit dimensions into a dimension score (DS) to determine which dimensions are dominant in research and which dimensions tend to be underrepresented (see Figure 3).

At the very top of the ranking is the measurement of Efficiency) (DS=51) criteria, closely followed by Costs (DS=48). The average process or activity execution time (per agent), the number of transactions (per period and agent), and FTE savings are very prominent metrics to measure various RPA benefits related to the Efficiency or Costs dimensions, with 19, 14, and 12 references, respectively. Moreover, accuracy or the error rate (12 references) is a popular measure to assess Quality and Compliance-related RPA benefits. These frequent references are presumably due to the corresponding data being generally quantitative in nature and therefore easy to collect and to measure. In addition, economically oriented key metrics and indicators, such as efficiency and cost criteria, are probably of greater popularity in practice. Accordingly, these are metrics of high interest, while other metrics appear less relevant. Metrics and indicators of the dimensions Compliance, Quality and Scalability and Flexibility show a DS of 26 (Compliance) and 25 (Scalability and Flexibility and Quality) and are therefore quantitatively concentrated in the middle DS range. The assessment of Implementation Effort, Employee and Customer Satisfaction, and Availability and Interoperability do not seem particularly prevalent. Implementation Effort has a DS of 16 and Employee and Customer Satisfaction only 14. A small DS of six is linked to Availability and only four to Interoperability. This may be because most of these dimensions and their associated metrics/indicators are challenging concepts to measure. As they are difficult to quantify, the effort required to collect and assess indicators to measure these dimensions is likely to be tremendous. Thus, assessing RPA benefits shows a tendency toward quantifiable, economic metrics and indicators, rather than qualitative and noneconomic ones.

With respect to RQ3 and RQ4, Table 2 presents our findings in the form of an author-

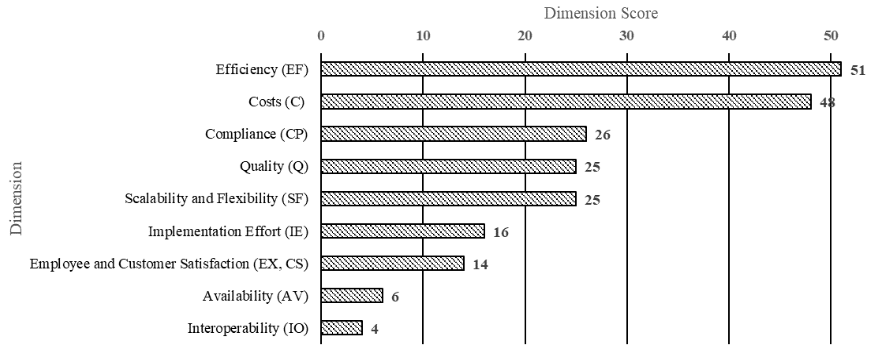

Figure 3. Ranking of RPA benefit dimensions based on dimension scores

centric concept matrix. Within the table, various evaluation methods are presented, which the respective authors either used or proposed to use in terms of RPA benefit assessment. Some methods were logically inferred from the contributions, even though they were not explicitly mentioned. For example, the comparison of data and metrics prior to and after bot implementation is often inferred from the presented metrics.

The majority of authors (43%) did not mention any evaluation method to assess RPA benefits. Several authors, however, proposed to use log data or to compare figures before and after RPA bot implementation to assess the realization of RPA benefits. This is mostly done for quantifiable data, such as process duration or transaction volume, which can be logged and archived more easily than qualitative data. Closely related are methods of process mining, which are, for instance, used by [6] to assess RPA bot performance or by [42] to collect necessary data for RPA evaluation. Others based their assumptions on surveys or suggested considering estimations and experience from experts to assess RPA effects, especially when it came to rather qualitative metric data like customer and employee satisfaction or aspects of quality. [59], for example, used questionnaires to gather data on whether the expected RPA benefits were achieved or not. Finally, some additional methods, such as bot benchmarking, interviews, user acceptance tests, and user interaction analysis, were proposed or deployed by other authors to measure single aspects of RPA effects. [10], for example, compared their

RPA bot data with that of a control group without bots in terms of transaction volume and duration. As can be seen, several authors used or proposed to use certain methods to evaluate RPA benefits, but this was not common practice, and often only single metrics and indicators were covered by these procedures. A holistic approach to assess multiple RPA benefits is still missing.

Table 2. Concept matrix: Evaluation methods for RPA benefits

Sources	Number of references	Evaluation method
[9, 11, 17–19, 31, 58, 60–64]	12	• none mentioned
[20, 24, 25, 28, 65, 66]	6	• comparison of data and metrics prior and after bot implementation (e.g., historical data, as-is-process)
[6, 28, 42, 56, 66, 67]	6	• log data analysis
[36, 57, 67]	3	• estimations and experience (e.g., concerning development costs)
[59, 68, 69]	3	• surveys (e.g., for customer satisfaction and employee experience factors)
[6, 42]	2	• process mining
[10]	1	• comparison of bot performance with that of a control group
[6]	1	• bot benchmarking
[57]	1	• user acceptance tests
[6]	1	• user interaction analysis
[59]	1	• interviews

5 Literature-based Research Agenda on Metrics, Indicators, and Evaluation Methods of RPA Benefit Assessment

To answer RQ5, we examined research desiderata that were addressed in the relevant literature and are deemed pertinent to the assessment of RPA benefits. As a result, challenges and research gaps were identified as parts of the following literature-based research agenda:

- **Review and broad validation of RPA benefit assessment approaches**: Metrics, indicators, and evaluation methods for RPA benefit assessment should be carefully reviewed in practice. These comprise the critical consideration of existing metrics and indicators, as well as their practical validation. The existing metrics and indicators shall be tested for deficits, redundancy, and suitability, as [42, 56] state. This also applies for RPA evaluation methods and means investigating further RPA implementation cases [20, 56, 59]. As [67] states, estimations, for example, are often imprecise and therefore not necessarily suitable. Thus, the further development of alternative evaluation methods like robotic process mining (RPM) [56], the adjustment of event-log structures [42], or the attempt to quantify indicators [56] should be addressed. The adaptation of the measured criteria by means of weights to consider different importance levels of the respective indicators [42, 56] is also a conceivable possibility, although requiring further research.

- **Identification and development of missing RPA benefit metrics and indicators:** Various authors denote that the list of indicators and their dimensions may not be exhaustive [42]. Therefore, further metrics/indicators should be developed for individualized assessment purposes, such as development time [19, 60], the consideration of industry-specific indicators [42, 60], or additional variables to assess user acceptance [69]. This includes a more holistic course, since social and organizational implications are rather insufficiently investigated [42]. Furthermore, [61] suggests assessing the robustness of RPA (e.g., in terms of changing user interfaces and standardization), and [11, 60] propose to include risk assessment in the RPA assessment practice. [11] points out that the quality of RPA tools is significant and should be considered as well.
- **Analysis and adaptation of RPA tools in terms of RPA benefit assessment:** RPA tools still provide various metrics and methods to assess RPA benefits. Comparison and complementation of the results reported in Section 4 with existing metrics, indicators, and evaluation methods used in RPA-specific tools would be essential for both future research and real-world application. Vice versa, functionalities of RPA tools that assess RPA benefits should be adapted, too. For instance, as these tools usually work with log data to analyze RPA performance, a careful analysis and adaptation of such log structures would be vital.
- **Cognitive RPA, intelligent automation, and integration with other systems:** Various authors suggest analyzing the transition from simple to intelligent RPA by inducing artificial intelligence [10, 61, 67] to go, for example, beyond rule-based task execution [11], like email processing or using analytic capabilities [24]. This shift from simple to advanced RPA should be taken into consideration in terms of RPA assessment, which might make the adaptation of corresponding metrics and indicators necessary.
- **Embedding of RPA into existing frameworks:** Some authors considered it necessary to embed RPA into the BPM lifecycle or other existing frameworks (e.g., ITIL, COBIT) [10, 61] to decide which automation approach is most suitable and to provide more guidance with respect to a complex RPA landscape [61]. This includes defining a model for RPA governance [24], which also affects RPA assessment and for which an overall framework is essential.
- **Assess organizational changes and changing work environments**: Further RPA automation impacts organizational structures as well as working environments or new services (e.g., Robot-On-Demand [28]) and, thus, might make reskilling or redeployment necessary [42, 67]. Organizational changes [67], the adequate

allocation of tasks between RPA bots and humans [67, 70], a new form of process documentation to avoid knowledge loss [24], long-term effects, and employee satisfaction [67] should all be examined in more detail.

6 Discussion and Conclusion

RPA is a new technology that uses softbots to automate processes in a different way compared to existing automation approaches. As interest in RPA grows, so does the need to demonstrate its promised positive effects. However, it seems that most articles on RPA merely mention its benefits without providing evidence for their assessment. To avoid misconceptions about the positive impact of RPA and to prevent companies from making misinvestments, this paper provides an initial overview of the current state of relevant metrics, indicators, and evaluation methods.

By means of an LR, we have made three major contributions in this paper. First, we extracted 62 unique metrics and indicators that are used or proposed by the respective authors for RPA benefit assessment and subsumed these under nine dimensions. Second, we identified ten evaluation methods to assess RPA benefits. For both reflections, we examined the number of references more closely to see which dominate the scientific discourse. Whereas Efficiency and Costs criteria (e.g., process duration, transaction volume, FTE savings) are prevalent in terms of indicators and metrics, it becomes apparent that the majority of contributions do not mention any specific evaluation method. Third, we established a research agenda comprising six topics, which shows that RPA benefit assessment still faces numerous challenges and research gaps.

A well-known limitation of any LR is that not all relevant literature may be included. Even though we conducted an exhaustive search of five information system databases that led to the identification of 861 results, we cannot ensure that every single publication of relevance has been considered. To guarantee traceability and approximate relevance, however, we documented our methodological process in detail.

Another limitation of our analysis is the conceptualization into nine RPA benefit dimensions, which does not claim to be completely distinct or exhaustive. Other researchers might come to different conceptualizations. A major challenge was to adequately reflect and categorize each metric, indicator, and evaluation method. In some cases, we had to generalize metrics for a better categorization and for reasons of synthesis. In other cases, some metrics, indicators, and evaluation methods were presented in more detail than was originally done by the respective authors.

Nevertheless, the paper at hand provides an overview of RPA benefit assessment with indicators, metrics, and evaluation methods, as well as an associated research agenda. The results can serve as an initial guide for research and practice to select a suitable approach for assessing the desired RPA benefit dimension from the multitude of approaches shown. In addition, scientists can use the research agenda as a starting point for future research on RPA benefit assessment.

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