Robotic Process Automation

A Comparative Analysis of the Current Market Solutions

Extended Abstract

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Abstract: RPA market solutions are offered with very divergent business models and capabilities. RPA's maturity level is still relatively low and its technological context is constantly being redefined. Comparative analyses for RPA solutions are practically non-existent and do not easily allow its customization with criteria specified by the company that wishes to select the solution. Therefore, a question arises: Is it possible to create an artifact that allows us to select the best RPA tool, given a certain reality, business area, own and particular requirements? This study used a DSR methodology approach to build an artifact that allows to produce a set of indicators that will support a sustainable choice of the RPA solution better adjusted to each company and/or business process. The artifact includes: an overview of existing solutions in the market and their distinctive characteristics; a comparative analysis of the RPA solutions using a specific framework; and a methodology to classify each solution degree of adaptability to automate specific business processes. A real case scenario was used as a demonstration where the artifact was applied and tested. This test demonstrated the artifact's ability to produce the indicators required by this study goals;

1 INTRODUCTION

Robotic Process Automation (RPA) is a recent concept in process automation that entails diverse methodologies, approaches and business solutions, and its supported by numerous tools and solutions offered in the market. Being the domain of this study the RPA solutions in the market, it will focus particularly on the study of these solutions, their manufacturers and how each of them approach the processes automation.

1.1 RPA - What Is It?

In its essence, RPA is a set of software "tools" that can be used to automate the tasks typically performed by real users, mimicking the actions performed by those users and using exactly the same systems and existing user interfaces. Although the term "Robotic Process Automation" can easily induce the view of physical robots performing tasks generally executed by humans, the real meaning of the concept is the automation of these tasks through software solutions. At the business process level, the concept generally refers to the configuration and use of software to perform the repetitive and low-value work previously done by people, for example the transfer and integration of data from multiple sources such as email and spreadsheets in to ERP or CRM systems[1].

Existing RPA solutions take advantage of emerging technologies such as analytics, machine learning, AI, and rules-based software to capture and interpret data sources, execute transactions, manipulate data, and communicate with other business systems. All this always based on predefined rules and procedures, autonomously and without human intervention.

RPA is a very recent concept with a still low maturity, but has experienced a great technological growth and a very strong business spread in the last year [2].
1.2 Research and Objectives

The selection of a software solution that best fits a particular function is a process that can be time consuming, complex, costly and involve a high degree of risk. If this solution is focused in to automate business processes, this impact increases significantly. Given that RPA's maturity level is still relatively low and its technological context and scope are constantly being redefined, companies wishing to adopt this concept are faced with a question: Is it possible to create an artifact that allows us to select the best RPA tool, given a certain reality, business area and own and particular requirements? Comparative analyses of the various RPA solutions are practically non-existent and do not easily allow to customize the analysis with criteria specified by the company that wishes to select the solution. The objective of this study is to create an artifact that will produce a set of indicators to lever a sustainable choice of the RPA solution that is more adjusted to each company and/or business process. Design Science Research (DSR) was the methodology chosen to support this study.

1.3 Design Science Research (DSR) As The Study Support Methodology

Design Science Research (DSR) is an approach with a growing relevance in information systems research and concise principals, guidelines and methodologies have been proposed to support the its use in IS research [3], [4]. DSR is based in the design of an artifact that aims to ensure answers to the questions posed by the study problem. It is an approach that perfectly fits the current study purpose and as such was the methodology used to guide it. DSR process model [4] entails six main activities that guided the work done on this study:

a) Identify the problem: research problem is clearly defined as the lack of indicators that allow a sustainable choice of the RPA solution that best fits to a reality, business area and particular requirements of each company. Companies that intend to adopt this concept are faced with serious difficulties in making a sustained selection without this set of indicators.

b) Define objectives of a solution: the objectives of this study are defined as the production of an artifact that allows and supports the creation of this set of indicators, to achieve this the artifact should be able to provide answers the following research questions, RQ1: Which RPA solutions are there in the market?; RQ2: Which distinctive features do they have?; RQ3: How the various solutions compare to each other? and RQ4: Which RPA solution best fits certain reality, business area and particular requirements of a specific company or business process?

c) Design and Development: The artifact development process is described in sections 2 and 3 which include a summary of related work and the construction of the artifact itself.

d) Demonstration and f) Evaluation: a real business process was used to test and evaluate the artifact.

e) Communication: Materialised on this article.

2 RELATED WORK

The domain of this work is the concept Robotic Process Automation; however, its central focus is the comparative analysis of RPA solutions in the market. To elaborate this analysis, it is vital to use credible methods to make it reliable and credible. Thus, this research on related work was be divided into two distinct areas, 1: the RPA and its market solutions; 2: the methodologies used for software solutions analysis.

2.1 RPA Current Market Solutions

Business processes optimization and efficiency improvement has been the focus of several approaches over time, the introduction and innovation in applications and business systems, the use of BPM tools and the outsourcing of processes and services are just a few examples [5]. The 2008 financial crisis put an additional pressure on private and public companies to reduce costs and produce more with less resources. RPA has introduced another possible approach for companies to alleviate this pressure [6]. RPA's success is starting to have a significant expression, presenting considerable gains at various levels and motivating the growing interest of companies. An analysis of about 20 real use cases in companies from different market sectors, [2], [1], [7], [8], presents the impact, benefits achieved, and show's a 68% increase in RPA adoption during the year 2016. There are several other use cases analysed during the research carried out for the current study, focusing on areas as diverse as financial services or supply chain services and transports [9], [10], [11], [12].
2.2 RPA Main Solutions And Vendors

RPA solutions are offered by vendors with very different business models ranging from exclusive software manufacturing to the “turnkey solutions”, or even providing the RPA service in the cloud: RPA as a Service. The commonly used approaches are by companies implementing service automation are, 1: Acquire the software and build the solution with internal resources using the support of the manufacturer, 2: Acquire the software and contract external consulting services to implement the solution; 3: Contract with a traditional Business Process Outsourcing (BPO) partner who uses service automation as part of their business model; 4. Contract with one of the new BPO providers who base their business model on service automation and are experts in the field and 5: Acquire service automation in the cloud, Service Automation as a Service [13]. The current research is aimed at RPA software solutions and will focus only on the pure RPA solutions in which its suppliers have the development and sale of RPA software as their main business model, being considered manufacturers of the software in question.

Several contacts were made via email, telephone and webforms with potential RPA solution providers to obtain detailed information, on-line and face-to-face demonstrations, as well as test software versions. Based on the responses received and considering the above criteria, the list of suppliers and solutions to be analysed in this study is presented in figure 1.

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product</th>
<th>Headquarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation Anywhere</td>
<td>Bot Insight, BotFarm, IQ Bot</td>
<td>U.S.</td>
</tr>
<tr>
<td>Blue Prism</td>
<td>Blue Prism</td>
<td>U.K.</td>
</tr>
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<td>Kofax</td>
<td>Kofax Kapow</td>
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</tr>
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</tr>
<tr>
<td>Nice</td>
<td>Nice RPA</td>
<td>Israel</td>
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<tr>
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<td>Pega Robotics</td>
<td>U.S.</td>
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<tr>
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<tr>
<td>Softomotive</td>
<td>ProcessRobot</td>
<td>U.K.</td>
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<tr>
<td>UiPath</td>
<td>UiPath</td>
<td>U.K.</td>
</tr>
<tr>
<td>WorkFusion</td>
<td>Smart Process Automation</td>
<td>U.S.</td>
</tr>
</tbody>
</table>

Figure 1 - RPA Vendors

2.3 Information Research And RPA Solutions Study.

The methodology used to collect information, study and analyse the RPA solutions in the market was based on the methods identified in figure 2. These methods were restricted by the information received that was not homogeneous, as is the case of test versions that were not provided by all manufacturers.

The information collected here, the study, analysis of the RPA solutions and knowledge acquired through the stated methods, established the support for all the subsequent development process and use of the artifact that is object of this study.

2.4 Software Analysis Methodologies

A study developed by Mohamed et al [14] analyses several research studies aimed at evaluating and selecting COTS (Commercial Off-The-Shelf) software. The various approaches differ in methodologies, but all conclude that a software analysis to be credible requires two essential factors, a set of rigorous and measurable criteria; and a reliable methodology for comparing them.

2.4.1 Analysis Criteria.

ISO / IEC 9126-1 indicates a quality model for evaluating software solutions, this model is based on six software quality criteria: Functionality, Reliability, Usability, Efficiency, Maintainability, Portability. These criteria are then decomposed successively into sub-criteria and attributes until comparable and measurable units are found that allow the software solutions to be analysed.

Various studies and analysis use this approach as a basis, customising or complementing them with specific criteria for the field of study and related to the specific requirements of use, [15], [16], [17], [18].

This study follows a recommended approach [18], [17] where the criteria in ISO 9126-1 serve as a basis for the study and are later subdivided and adapted to the study domain, in this case of RPA solutions.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Automation Anywhere</th>
<th>Blue Prism</th>
<th>Kofax</th>
<th>Kryon Systems</th>
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<th>Pega</th>
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Figure 2 - Information research and study methodology
2.4.2 Analysis Methodology.

Decision making in software selection is a problem that can be addressed as a MCDM, multi-criteria decision making [19]. There are several methods of MCDM and various authors have performed comparative analysis on the most common methods [19], [20]. Among these methods, the AHP - Analytic Hierarchy Process [21] is referenced [19] as being one of the most used and with best results in software analysis and selection. This study will use AHP supported in several scientific works in this area [15], [16], [22], [23], [24], [25], [20], [26], [17].

3 ARTIFACT DEVELOPMENT

The artifact aims to provide answers to the four research questions of this thesis. To this end, the architecture of the artifact was developed based on specific components that allow answering the research questions. These components will be described in the following sections and are organized and identified by the study questions that they propose to answer.

3.1 RQ1: Which RPA Solutions Are There in the Market? and RQ2: Which Distinctive Features Do They Have?

To answer this question it is necessary to identify the RPA vendors and solutions available in the market, and to provide an overview of them that contains, 1: Vendor identification; 2: Descriptive summary of the vendor; 3: A summary of the most distinctive features and functionalities of each solution; 4: Preferred market sectors for the RPA solution; 5: Customers where the company has RPA solutions installed; 6: Usually automated business processes by the RPA solution; 7. Vendor partners in the RPA domain; 8. Vendor headquarter and 9. Vendor website. A table was created to gather this information and will be completed when using the artifact.

This information is the first component of the artifact and provides answers to research questions 1 and 2.

3.2 RQ3: How The Various Solutions Compare To Each Other?

In order to answer this question, the artifact must enable a comparative analysis of the RPA solutions by evaluating each of them in relation to a set of criteria relevant to the RPA domain. The criteria used in this study were set out based on section 2.4 and the criteria customization to be in line with RPA domain was done taking in account the following sources:

1. Generic Criteria: Research on analysis and selection of software: [27], [19], [17], [14], [16], ISO / IEC 9126-1

2. RPA Domain Specific Criteria: based on RPA related research and work: [13], [2], [28], [8], [6], [7], [1], [12] and [29]

3. RPA Baseline Features: Criteria based on the characteristics globally presented by suppliers as being "mandatory" for RPA solutions success.

These criteria are presented in figure 3 divided in functional and non-functional characteristics.

To perform the analysis, these criteria are inserted into specific tables, figure 5, where each solution will be evaluated according to its response to each of the criteria and using the weights 0: Not implemented; 1: Weak; 2: Medium; 3: Good; 4: Excellent.

![Figure 3 - Analysis Criteria](image-url)
The analysis carried out in these two tables is the second component of the artifact allowing to answer the research question 3.

**RQ4: Which RPA Solution Best Fits Certain Reality, Business Area And Particular Requirements Of A Specific Company Or Business Process?**

To answer this question the artifact must enable a comparative analysis based on a set of criteria specifically selected to respond to the particular requirements elected. It should also provide a method, using these criteria, for comparing the various solutions. The following sections describe how the artifact achieves these objectives.

### 3.3 Customizing The Artifact To The Analysis Reality

The artifact constructed in this thesis allows its customization to the reality of analysis and can be used in a general or particular way being personalized according to the type of analysis that the companies intend to carry out.

#### 3.3.1 Customizing For General Analysis.

In this case, all the analysis criteria defined in figure 4 (Analysis Criteria) are used and the resulting analysis is a holistic analysis of the RPA solutions selected for study.

#### 3.3.2 Customizing For Specific Analysis.

In this case the artifact will be customized so that the list of criteria to be evaluated includes only those that are considered relevant to the analysis in question, examples of which are the adaptability analysis to a particular business process or simply an analysis based on a subset of criteria that the company considers relevant. The artifact has a way of assigning specific weights to each criterion, thus guaranteeing the possibility to create analysis where it is required to emphasize the importance of certain criteria in relation to others.

### 3.3.3 Method For Analysing The Degree Of Adaptability To Specific Cases

The method for assessing the degree of adaptability of RPA solutions to specific cases is based on a comparative analysis of the solutions using a subset of the criteria considered most relevant to each case. This analysis can be considered a multicriteria decision making (MCDM) and its accomplished using the method AHP - Analytic Hierarchy Process [21]

#### 3.3.3.1 The AHP Method.

The AHP method is one of the main mathematical models applied in multicriteria decision making, where several variables or criteria are considered to evaluate several proposed alternatives. Based on a scientific methodology, the method allows analysing the various criteria that influence decision making and, consequently, generating information that supports the decision maker to choose the best of the alternatives proposed, based on the criteria analysed. Rather than determining the right decision, this...
method makes it possible to justify the choice consistently and consistently. The method was developed in the 1970s by Thomas L. Saaty [21] and has since been extensively studied and refined. The multicriteria decision analysis can be understood as a methodical process, which consists of the following basic activities, 1: Define a set of criteria that the selected product must meet; 2: Assign a weight to each criterion, which represents its importance for the success of the system being developed; 3: Evaluate the suitability of each product based on the criteria that represent the requirements of the users; 4: Classify products according to how well they meet the criteria. Thus, the use of the AHP method starts by decomposing the problem into a hierarchy of criteria that can be easily analysed and compared separately. Weights should then be assigned for each of the criteria by defining the relative importance of each. After this step, decision-makers systematically evaluate all alternatives by means of one-to-one comparison within each of the criteria. For the attribution of weights and comparison of alternatives a scale of values as indicated in figure 6 should be used. Scale values \{1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9\} may also be used to represent inverse importance.

The weighting of the evaluation criteria is critically important in the analysis success when using the artifact in a real case. An evaluative criterion can have different weights depending on its impact on the business process, or due to the relative importance that each evaluator gives to this criterion.

When all comparisons are made, the AHP method allows the numerical probability calculation for each of the alternatives. This is the probability that the alternative has to respond positively to the established criterion. The higher the probability, the greater the probability that the alternative will reach the goal.

The AHP method uses a complex mathematical model and is outside the scope of this thesis, however, there are several software solutions on the market that allow the application of the AHP method abstracting the end user from the calculations required by it. The solution used in this thesis was developed at the Czech university Palacky University Olomouc and is described in detail in the article [30]. This solution, besides being of free use, is designed to work in a browser environment allowing its use in a wide set of devices. The solution can be accessed at: http://fuzzymcdm.upol.cz/fuzzyahp/CriteriaList

4 USING THE ARTIFACT

This section shows the use of the artifact to create an analysis of the degree of adaptability of RPA solutions to a specific real case. In the following subsections, the first two components of the artifact will be used, producing the answers to the first three research questions, RQ1: "What RPA solutions exist in the market?"; RQ2: "What distinctive features do you have?" And RQ3: "How do you position the various solutions between them?" These responses and the generated information are then applied together with the third component of the artifact to obtain the answer to RQ4: "Which RPA solution best fits certain reality, business area and particular requirements of a specific company or business process?"

4.1 Existing Solutions In The Market And Its Distinctive Characteristics

Figure 7 presents an example of the artifact answers to RQ1 and RQ2. The first component of the artifact thus guarantees the answers to questions RQ1: "What RPA solutions are there on the market?" And RQ2: "What distinctive features do you have?"

In the following chapter the artifact will be used to generate the answers to RQ3.

Figure 7 – Vendor analysis example
### 4.2 RPA Comparative Analysis

This chapter demonstrates the use of the second component of the artifact to obtain the answers to the RQ3 research question: "How do the various solutions position each other?" The artifact is based on a set of criteria that are divided into two strands, functional and non-functional, as such, specific analyses have been created for each of the strands and are showed in figures 8 and 9.

<table>
<thead>
<tr>
<th>Automation</th>
<th>Aikiflow</th>
<th>Blue Prism</th>
<th>Kosmos</th>
<th>Keto Systems</th>
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<th>Page Systems</th>
<th>Redwood Software</th>
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#### 4.3 Adaptability Degree of Each Solution to the Automation of Different Business Processes

In this section, the information generated previously by the artifact will be used in conjunction with the third component of the artifact in order to obtain answers to the RQ4 research question: "Which RPA solution best fits certain reality, business area and particular requirements of a specific company or business process?"

#### Figure 8 - Functional analysis

<table>
<thead>
<tr>
<th>Development</th>
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<tr>
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<td>11</td>
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<td>10</td>
<td>9</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

#### Figure 9 - Non Functional analysis
Since the artifact will study the solutions adaptability to a specific business process the following subsections will present the business case under study and the artifact customisation to this specific case.

4.3.1 Specific Business Process Analysis.

The business process chosen to validate the artefact in analysing the adaptability degree of the RPA solutions is a real business process from Infarmed (http://www.infarmed.pt/) in which a set of information from several sources is aggregated in a portal, analysed and handled by specialized operators who later register it in their own applications and business repositories.

An example of this portal can be accessed at https://placotrans.infarmed.pt/Publico/ListagemPublica.aspx. This business process fits into what are commonly referred to as swivel chair business processes and where RPA and its solutions have an excellent fit. [1]. Figure 10 summarizes the process in question.

![Figure 10 - Specific business process chosen to validate the artefact in analysing the adaptability degree of the RPA solutions](image)

4.3.2 Customizing The Artifact To Create The Business Process Analysis.

Taking into account the specific requirements of the business process in question, the set of analysis criteria was "filtered" to include those considered most relevant and indicative of the RPA solutions degree of adaptability. Only functional criteria are considered; however, if it is required to analyse non-functional criteria, the process can be repeated for those specific criteria. Figure 11 presents the subset of criteria considered for analysis.

![Figure 11 - Functional criteria used on adaptability degree analysis](image)

4.3.3 Adaptability Degree Of Each RPA Solution.

To create this analysis go to http://fuzzymcdm.upol.cz/fuzzyahp/CriteriaList and enter the criteria considered for analysis (step 1) and the considered RPA solutions (step 2). In step 3 all users who will perform the evaluation should be listed, in this case only one user is nominated, but it is advisable to carried out the evaluation with several users, which will increase its accuracy. In step 4, FuzzyAHP allows the definition of scenarios, this option is not required for this analysis and as such should not be entered information. In step 5 (figure 12) the relative weights of each criterion must be established, in this step the user must define the relative importance of each criterion with respect to the others using the reference values in figure 6 (Saaty Table). It is only necessary to fill the values above the diagonal since FuzzyAHP fills the rest automatically.

![Figure 12 - Criteria weights](image)

In steps 6 to 16 the solutions are evaluated using each of the defined criteria (figure 13), establishing the position of each solution in relation to the others. The user should use the tables created in section 4.2 where a preliminary analysis of the response of each solution according to the various criteria has already
been carried out. The importance (position) of each solution over the others should be expressed using the values indicated in figure 6 (Saaty table).

Set Saaty matrix

<table>
<thead>
<tr>
<th>Automation</th>
<th>Blue Prism</th>
<th>Kofax</th>
<th>Anyka Systems</th>
<th>Blue</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation Anyka</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
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<td>0.32</td>
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</tr>
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<td>1</td>
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<tr>
<td>Page</td>
<td>0.009</td>
<td>0.01</td>
<td>0.01</td>
<td>0.05</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 13 - Solution analysis example for one of the criteria

After the solutions analysis according to the established criteria has been carried out, FuzzyAHP presents in step 17 the final output of the evaluation, these results are shown in figure 14. The artifact thus produces the answer to the RQ4 research question.

The overall results

<table>
<thead>
<tr>
<th>Automation Anyka: 0.14 0.14 0.14</th>
<th>Blue Prism: 0.129 0.129 0.129</th>
<th>Kofax: 0.999 0.09 0.09</th>
<th>Anyka Systems: 0.395 0.095 0.095</th>
<th>Blue: 0.005 0.004 0.004</th>
<th>Page: 0.009 0.01 0.01</th>
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<tr>
<td>0.009 0.09 0.09</td>
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</tr>
</tbody>
</table>

Figure 14 - Overall results

5 EVALUATION

During its use in the analysis of a real case the artifact did indeed produce the answers required by the study questions. These responses, and the information produced by them, constitute the set of indicators that the artifact was intended to produce and will enable a sustainable choice of the RPA solution that best fits to a reality, business area and particular requirements of each company.

The artifact proved to have a very good usability, its learning is extremely simple and the inclusion of an easy to manipulate and access webtool to carry out the comparative analyses and to make the respective probabilistic calculations, proved to be an extremely useful component that significantly facilitates the whole process.

The device thus responds fully to the objectives for which it was built.

6 CONCLUSIONS

Robotic Process Automation (RPA) is a recent concept in process automation that encompasses several areas and strands and is supported by numerous tools and solutions offered in the market. There are a number of vendors on the market offering RPA solutions with very different business models ranging from exclusive software manufacturing to the provision of so-called "turnkey" solutions or even providing the RPA service in the cloud: RPA as a Service. Companies wishing to adopt this concept are faced with the problem of selecting the most appropriate RPA tool for a given reality, given the differences in approaches promoted by different manufacturers.

This study used a DSR methodology DSR approach to create an artifact that allows to produce a set of indicators that support a sustainable choice of RPA solution that is more adjusted to each company and/or business process. The artifact includes, 1: Identification of solutions available in the market and their distinctive characteristics; 2: Comparative analysis of the characteristics of the various solutions, using a specific framework and 3: A classification of the degree of adaptability of each solution to the automate specific types of business processes;

The use and demonstration, in a real case, of the artifact created in this study is a vital part of it that substantially consolidated it and provided several improvement indications that were iterated in to the artifact. This demonstration proved the artifact’s capability to provide the answers required by the research, generating a set of indicators that allows to support a sustainable choice of the RPA solution that best fits each company and/or business process.

The analysis of the real case was carried out with the sole recourse of an evaluator, this may be considered a limitation because the analysis produced does not detain the rigor and quality that would be obtained if the artifact were, as is assumed, used by several evaluators simultaneously. In future work, it will be interesting to test the use of the artifact in other business processes and study the use of the artifact by several end users simultaneously.
REFERENCES


